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# NATIONAL ENVIRONMENTAL RESEARCH CENTER - LAS VEGAS: A STAFF STUDY

Environmental Protection Agency
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JANUARY 1973

Prepared by:
Laboratory Operations Division
Office of Research and Monitoring

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## PREFACE

The present study was commissioned by the Assistant Administrator for Research and Monitoring, EPA. Proceeding from a set of assumptions supplied by the Assistant Administrator, the study originally was to develop a master plan for NERC-Las Vegas and to outline specific projects that should be undertaken at the NERC through the period FY 1974 to FY 1980. However, extensive comments were received from Headquarters and from the National Environmental Research Centers on the first draft of this study, necessitating new guidelines and a redefinition of the scope of the study. There was evidence that the reviewers differed substantially as to the meaning of a NERC's research theme. Some of the NERC's clearly viewed certain areas of research as their exclusive domain, even though efforts in these same areas were already underway at other NERC's. The many vested interests of these reviewers, and the lack of a uniform philosophy underlying the NERC theme concept, resulted in major conflicts with the study's original guidelines and assumptions. Consequently, the purpose of the study was shifted to lay out the ORM managerial philosophy for evolution of NERC-Las Vegas into a center emphasizing research and monitoring approaches that go beyond the narrow confines of a single medium.

This study represents a "first step" in the short- and long-range planning of the future of NERC-Las Vegas. Many additional steps must be taken—as outlined in the report—if the Las Vegas laboratory is to evolve into a National Environmental Research Center having a fully integrated, balanced, and effective research program.

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***The Director, Laboratory Operations Division, takes full responsibility for the content and recommendations presented in this report. They reflect the Director's opinions, based on his review of the material assembled by the study committee.**

## SUMMARY

This staff study undertakes a comprehensive examination of the future of the Environmental Protection Agency's Office of Research and Monitoring (ORM) Laboratory at Las Vegas, previously known as the Western Environmental Research Laboratory. This laboratory was officially designated a National Environmental Research Center (NERC) by the Administrator, EPA, on July 13, 1972.

Like the other three NERC's, NERC-Las Vegas has been assigned a research theme on which to build its capabilities and expertise. Its theme is "environmental monitoring". Unlike the other three NERC's, NERC-Las Vegas has an extremely small, narrowly-defined research program. Research activity at Las Vegas has been limited primarily to radiation areas, with the National Eutrophication Survey being the only program at the NERC outside traditional fields of radiological research.

This study is intended to lay the groundwork for the evolution of NERC-Las Vegas into a Center emphasizing approaches that go beyond a particular aspect of environmental pollution—be it water, air, or land—and viewing the environment as an integrated unit. First, an extensive review was made of the programs, facilities, resources, and research capability at Las Vegas. ORM monitoring-related programs at all four NERC's were then examined with emphasis on identifying unfulfilled research needs. In order to meet these needs and at the same time exploit the research capability of NERC-Las Vegas, a series of recommendations was developed based on the following rationale:

- The NERC Project Areas (NPA's) introduced in this report provide for unique functional areas of activity to be concentrated at a particular National Environmental Research Center.

- The operational base of ORM programs resides in the NERC's; responsibility for goal setting and policy planning resides in ORM Headquarters; responsibility for long-range planning and resource allocations rests with Headquarters in conjunction with the NERC Directors.

- No functions should be transferred from one NERC to another solely for the purpose of achieving alignment with a particular NERC's research theme.

- Any transfer of function must first be thoroughly considered on an individual programmatic basis—i.e., in the light of its program improvement, contribution to establishment of a critical mass of expertise, and improvement of operational efficiency.

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A number of the recommendations in this study pertain to the NPA's. NPA's define, intrinsically, the meaning of the research theme for a given NERC, since they spell out the areas of specialization centered at that NERC. NPA's could be identified for all four NERC's, but that was beyond the scope of this study. The following seven NPA's were identified for assignment to NERC-Las Vegas, however, and should be established there to provide a solid base for the NERC's research and monitoring program:

NPA 1. Special Staff Studies – These studies review the state-of-the-art of our knowledge in key monitoring-oriented areas for the purpose of focusing research questions clearly, of determining in detail the nature of existing unfulfilled needs, and of providing a direction for satisfying these needs.

NPA 2. Aerial Surveillance Support – The aerial support project area at NERC-Las Vegas provides needed assistance to on-going monitoring programs within the Agency as well as support to monitoring activities during environmental emergencies.

NPA 3. Development and Field Testing Of Aerial Remote Sensing – Research in this area emphasizes the design, development, testing, and evaluation of remote sensing instruments and methodology utilizing fixed or rotary winged aircraft.

NPA 4. Biological Monitors of the Environment – This research concentrates on the detection and measurement of selected pollutants in the biosphere using animal and plant systems as monitoring devices.

NPA 5. Development and Field Testing of Noise Monitoring Instrumentation – This project area focuses on the development of techniques, including associated standardization and quality control procedures, for routinely monitoring noise in urban areas.

NPA 6. Development and Demonstration of Monitoring Networks – Studies of this nature are aimed at developing optimal networks for measurement of long-term environmental trends, for setting standards as well as assessing compliance progress, and for determining the true exposure of the population and other elements of the environment to various pollutants.

NPA 7. Development of Data Interpretation Techniques – Projects in this area are directed at investigation of quantitative and analytical techniques within the context of monitoring problems as well as development of refined and improved mathematical and statistical methods for interpreting and evaluating environmental quality data.

NERC-Las Vegas has the capability to carry out effective programs within each of the recommended NPA's. However, with the limited resources available to the NERC, this capability is not at present being fully utilized, and the possibilities for obtaining additional resources appear to be slim. EPA's budget request for FY 1974 shows no substantial increases in research funds; if allowance is made for increased research costs due to inflation, the net effect will be, it appears, a *decrease* in EPA's annual research budget. Further, the prospects for research funding over the next two or three fiscal years will probably present a similarly dismal picture.

In this time of lean budgets, therefore, ORM must make every effort to secure more output for its research investment. ORM should take all possible steps to reduce excessive administrative costs, nonessential activities and any other operations which while useful in themselves are not crucial to the research product. As a result, operational functions which exist within Headquarters should be transferred to the field along with their associated resources to obtain the greatest possible program improvement and efficiency. Accordingly, the report makes the following additional recommendations to obtain such program improvement at NERC-Las Vegas and to provide guidelines for developing the NERC's capability:

- *Operational functions of the Advanced Techniques Division, Office of Monitoring, should be transferred from Headquarters to NERC-Las Vegas.*

- *Operational functions of the Data Audit Branch, Office of Monitoring, should be transferred from Headquarters to NERC-Las Vegas.*

- *Operational functions of the Quality Assurance Division, Office of Monitoring, should be transferred from Headquarters to NERC-Las Vegas.*

- *All intramural and extramural funds as well as positions associated with these functions should also be transferred to NERC-Las Vegas.*

- *NERC-Las Vegas should undertake a planning study to develop particular research projects and resource needs within each of the seven NPA's assigned to the NERC. The study should be consistent with the ORM planning system.*

- *An independent review should be undertaken to identify additional operational program activities in Headquarters that relate to the NPA's assigned to NERC-Las Vegas; as these are identified, they should be transferred to NERC-Las Vegas.*

- *NERC-Las Vegas should develop a new organizational structure to enable it to carry out its expanded role.*

- *Administrative services for NERC-Las Vegas should be provided by the Office of Planning and Management through a Director of Administration.*

- *EPA should enter into negotiations with the University of Nevada-Las Vegas to expand facilities on the University's campus in order to meet future facility requirements of NERC-Las Vegas.*

In summary, NERC-Las Vegas has the potential—the nucleus of people, the facilities, and equipment—needed to carry out a balanced, effective research and monitoring effort that is consistent with the NERC concept. But NERC-Las Vegas lacks the funds and positions to fulfill its potential. Only 55 positions, for example, are directly funded by ORM at Las Vegas, while NERC-Research Triangle Park and associated laboratories has an ORM commitment of approximately 630 positions; NERC-Cincinnati has 361; and NERC-Corvallis has 412. The tremendous research and monitoring capability at NERC-Las Vegas is, at present, severely under-utilized and will continue to be so unless strong and immediate action is taken.

# CHAPTER I

# INTRODUCTION

## A. Goal and Scope of Study

The goal of this staff study is to undertake a comprehensive examination of the future of the Environmental Protection Agency's Office of Research and Monitoring (ORM) laboratory at Las Vegas, previously known as the Western Environmental Research Laboratory (WERL). This laboratory was officially designated a National Environmental Research Center (NERC) in a memorandum from the Administrator, EPA, dated July 13, 1972.

The present study was commissioned by the Assistant Administrator for Research and Monitoring, EPA. Its purpose is to lay the groundwork for evolution of this laboratory into a center emphasizing research and monitoring approaches that go beyond the narrow confines of a single medium. This study is intended to provide guidelines for future programs, organization and utilization of facilities, at Las Vegas, consistent with the NERC concept and within realistic resource levels.

## B. Concept of NERC's

To develop an organization capable of efficiently integrating EPA's research and monitoring activities, the Assistant Administrator for Research and Monitoring established three National Environmental Research Centers in August 1971 (confirmed by EPA Order 1110.22). Many of EPA's research laboratories had been in existence for some time prior to that. However, the NERC concept, which fully integrates the technological expertise of laboratories formerly focusing only on a particular aspect of environmental pollution–be it water, air, or land–was developed by ORM. Each NERC consists of a critical mass of demonstrated experience and professional skills, suitable diversity of facilities, and program responsibilities related to its new and broadened mission.

Centers were established in Research Triangle Park (RTP), North Carolina; Cincinnati, Ohio; and Corvallis, Oregon. Each was assigned other existing laboratories–according to facilities, personnel, and programs–directly related to its mission. The programs at each NERC (consisting of a "center" and a system of associated laboratories) were developed along a "thematic basis", consistent with the role that the Center must play in the overall mission of the Agency. In developing the thematic bases, four criteria were considered:

- Existing research programs at the laboratory
- The research capability of the laboratory (staff expertise, facilities, and geographical location)
- The relationship of the programs to other existing programs

- The extent to which the program adds to the balance of research among land, water, and air areas.

The theme for NERC-RTP is health effects research; for NERC-Cincinnati, pollution abatement technology and engineering research; and for NERC-Corvallis, ecological effects research. Although each Center serves as a nucleus for an effective research effort, programs are not strictly limited to its specific theme. Rather, the sole purpose of the theme is to give to each NERC a foundation on which to build its capabilities and expertise in the assigned area. The NERC's can effectively plan to attack environmental problems on a highly sophisticated and integrated basis, covering all aspects of research with minimal fragmentation to determine source-exposure-dose-control relationships.

With successful development of the first three NERC's, it soon became evident that a major component of the environmental problem—environmental monitoring—was fragmented and uncoordinated and was not receiving the full efforts necessary to meet the legislative mandates. There was no ORM laboratory which could conveniently build an effective program around monitoring as a theme, meeting unfulfilled research needs and conducting the necessary research on how to integrate monitoring of the environment properly and effectively. This need was met with the designation of a fourth center, NERC-Las Vegas, with a theme of environmental monitoring.

In examining the significance of research themes, it should be noted that many research functions exist which are not the sole domain of any one NERC. Such research functions are pursued not as ends in themselves but as component parts of other research endeavors. Mathematical modeling, like statistics, cannot be restricted to any one NERC or to any one research sphere. Research in ecological areas, for example, may require construction of mathematical models or investigation of transport processes. Likewise, development of suitable knowledge in the area of monitoring may require data on the movement of pollutants through various points in the environment to determine what should be monitored and at what point. Tracing the movement of certain toxic materials through the food chain, for example, may be necessary to develop truly effective monitoring strategies for these pollutants. Such research, of course, would not be initiated at one NERC if others were already engaged in identical work; in each case, there must be extensive communication between the NERC's.

Many monitoring-oriented projects within ORM are intimately tied to programs which already exist at a NERC or provide a necessary balance to research activities at the NERC; where this is the case, more harm than good would result if the program were transferred solely for the purpose of achieving alignment with a particular research theme. Consequently, any transfer of function must first be thoroughly considered on an individual programmatic basis. The primary concern should be for program improvement, establishment of a critical mass of expertise, and improvement of operational efficiency.

### C. Approach of Study Committee

To plan the future role of NERC-Las Vegas, the Assistant Administrator for Research and Monitoring convened a small study Committee, with representatives from the Office of

Research, Office of Monitoring, and the Las Vegas laboratory. Dr. Ronald Engel, Director of the Laboratory Operations Division, Headquarters ORM, acted as Chairman, with this Division carrying the lead role in developing the study and assembling this report. In the review stages of the report, the study committee was expanded to include representatives from each of the three other NERC's, and their comments were carefully considered in developing the final document.

Figure 1 provides a flow chart of the general procedure followed in this study. The boxes at the left indicate the basic information the study committee used in developing this report. For the sake of simplicity, only the pertinent steps are included.

As a first step, the study committee examined what is meant by environmental monitoring, with particular emphasis on the implications of this theme for NERC-Las Vegas. Next, a major effort was made to identify overall research needs in the area of monitoring, irrespective of whether these needs are to be met at Las Vegas or at the other NERC's. This review examined (1) all monitoring-oriented research programs within the four NERC's, (2) current monitoring research literature, (3) monitoring research needs of the Regions and other program offices, (4) monitoring aspects of existing legislation, and (5) data contained in the ORM planning system. This review was directed toward identifying the highest priority unfulfilled research needs in the area of monitoring which are not currently addressed at any of the NERC's but which ultimately should be addressed by the NERC's.

Existing research capabilities at NERC-Las Vegas were surveyed in relation to environmental monitoring. This survey examined the professional skills and backgrounds of the research staff—their areas of special expertise, their previous research work, and the manner in which this competence can best be applied to environmental monitoring. Also examined as part of this review were the facilities and geographic features of NERC-Las Vegas, with particular attention to any unique installations and equipment which would be of benefit in conducting environmental monitoring research.

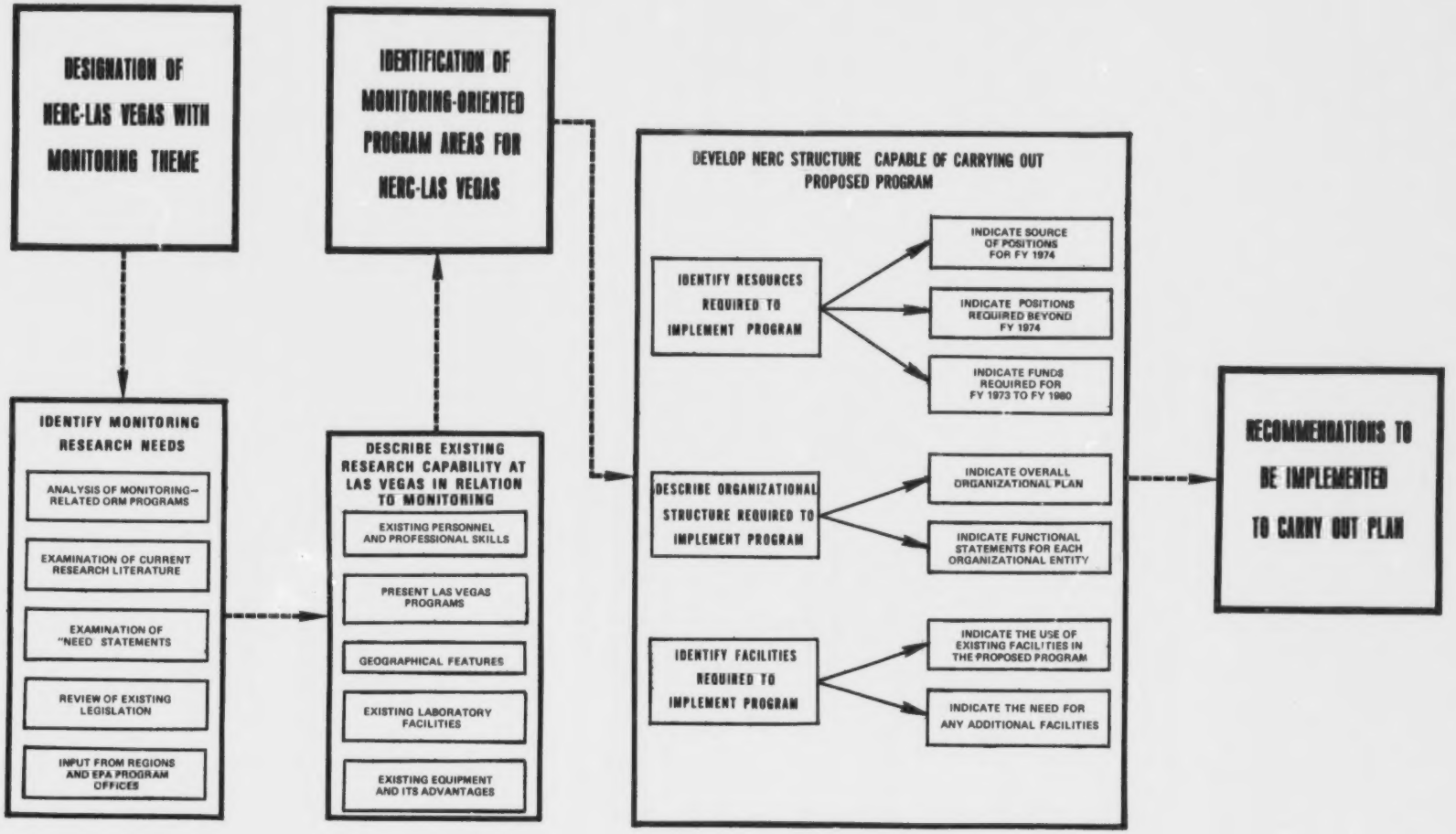
From this body of data, an attempt was made to identify research and monitoring program areas which could meet highest priority unfulfilled research needs at the same time that they exploited the existing research capability of NERC-Las Vegas (professional competence, facilities, equipment, and geographical location).

Once formulated, these program areas were used as the basis of a suitable organizational structure for NERC-Las Vegas, for examination of the NERC project areas and resources that would be needed to implement a viable program, and for determination of any modifications to existing facilities that might be necessary.

The study culminates in a series of recommendations pertaining to programs which should be assigned to NERC-Las Vegas as well as recommendations on the resources, organization, and facilities needed to carry out these programs.

# FIGURE 1

## FLOW CHART SHOWING GENERAL APPROACH OF THE STUDY


DESIGNATION OF NERC-LAS VEGAS WITH MONITORING THEME
IDENTIFICATION OF MONITORING-ORIENTED PROGRAM AREAS FOR NERC-LAS VEGAS
DEVELOP NERC STRUCTURE CAPABLE OF CARRYING OUT PROPOSED PROGRAM
IDENTIFY MONITORING RESEARCH NEEDS
ANALYSIS OF MONITORING-RELATED ORM PROGRAMS
EXAMINATION OF CURRENT RESEARCH LITERATURE
EXAMINATION OF "NEED STATEMENTS
REVIEW OF EXISTING LEGISLATION
INPUT FROM REGIONS AND EPA PROGRAM OFFICES
DESCRIBE EXISTING RESEARCH CAPABILITY AT LAS VEGAS IN RELATION TO MONITORING
EXISTING PERSONNEL AND PROFESSIONAL SKILLS
PRESENT LAS VEGAS PROGRAMS
GEOGRAPHICAL FEATURES
EXISTING LABORATORY FACILITIES
EXISTING EQUIPMENT AND ITS ADVANTAGES
IDENTIFY RESOURCES REQUIRED TO IMPLEMENT PROGRAM
INDICATE SOURCE OF POSITIONS FOR FY 1974
INDICATE POSITIONS REQUIRED BEYOND FY 1974
INDICATE FUNDS REQUIRED FOR FY 1973 TO FY 1980
DESCRIBE ORGANIZATIONAL STRUCTURE REQUIRED TO IMPLEMENT PROGRAM
INDICATE OVERALL ORGANIZATIONAL PLAN
INDICATE FUNCTIONAL STATEMENTS FOR EACH ORGANIZATIONAL ENTITY
IDENTIFY FACILITIES REQUIRED TO IMPLEMENT PROGRAM
INDICATE THE USE OF EXISTING FACILITIES IN THE PROPOSED PROGRAM
INDICATE THE NEED FOR ANY ADDITIONAL FACILITIES
RECOMMENDATIONS TO BE IMPLEMENTED TO CARRY OUT PLAN

## D. Organization of Report

Chapter I of this report, which serves as an introduction, outlines the goal of this study, the concept of National Environmental Research Centers, the research theme assigned to NERC-Las Vegas, the approach of the study committee in developing this report, and the overall organization of the report.

Chapter II discusses the history of the Las Vegas laboratory, its existing organization, the administrative services available at the NERC, the capabilities of its facilities and staff to undertake particular kinds of research, and the programs currently underway at the laboratory.

Chapter III outlines the monitoring programs within ORM; it discusses the nature of environmental monitoring, with emphasis on monitoring research, and it presents the results of an analysis of monitoring-related programs as they exist throughout the NERC's, paying attention to unfulfilled research needs which exist in our knowledge of how to monitor the environment effectively.

Chapter IV presents recommendations for the areas of work which should be assigned to NERC-Las Vegas, for the organizational arrangement of the NERC, for future facilities, and for the resources needed.

Appendix A describes in depth the existing facilities at NERC-Las Vegas, with emphasis on the unique capabilities of the equipment and installations.

Appendix B presents a review of current monitoring programs and activities in the Agency in greater detail than is possible in the body of the report.

## CHAPTER II

## BACKGROUND OF NERC-LAS VEGAS

This chapter provides general background information on the Las Vegas laboratory, with particular emphasis on its capability to perform particular kinds of research and monitoring. It discusses the history of the laboratory's development, the nature of its organization, and the arrangment of its support services. It then concentrates on the research capability of the laboratory, including a description of current programs at Las Vegas.

### A. History

The Las Vegas laboratory had its beginning in 1954, when the Atomic Energy Commission (AEC) requested the Public Health Service (PHS) to provide effective monitoring of radioactivity in the area surrounding the Nevada Test Site. This request resulted from the public's concern about the periodic release of radioactivity from nuclear weapons testing at the Nevada Test Site. In response to the request, the "Off-Site Radiological Safety Program" was created, funded by the AEC. Initially, an old warehouse at Mercury, Nevada, housed the program.

With the growth of the permanent staff from one in 1954, to two in 1955, and to about eight in early 1959, the laboratory moved to a larger building at Mercury and to the AEC's offices in Las Vegas. In 1958, when PHS's newly created Division of Radiological Health established its first radiological health facility in Las Vegas, the Off-Site Radiological Safety Program served as its nucleus. In December 1959, the laboratory moved to a larger building in Las Vegas to accommodate its staff of about 30.

By 1962, the staff had grown to over 100; and the State of Nevada offered the laboratory a permanent home on the campus of the University of Nevada-Las Vegas. The first building provided by the State housed a staff of about 50 people on the campus; the remainder were scattered throughout Las Vegas.

Ground was broken in 1965 for a new complex with 80,000 square feet of floor space on the University of Nevada-Las Vegas campus, and in 1966 this laboratory transferred 219 more people to the Campus. At its peak in 1968, the laboratory had a staff of 300 and an annual budget of $4 million. In 1970, staffing began to decrease because of reductions in the Plowshare program (peaceful applications of nuclear energy) and the AEC weapons testing activities.

Over the years, the Las Vegas laboratory's monitoring efforts in the radiation field expanded steadily and now include comprehensive sampling and monitoring in 21 Western States and other test areas such as Alaska and the South Pacific. The laboratory also conducts monitoring activities that originally were supported by PHS and are now supported by EPA's Office of Radiation Programs (ORP). ORP programs deal with the radiation hazards

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in and around nuclear power reactors, radiation exposure of the general population resulting from uranium mill tailings, and operation of five environmental radiation surveillance networks.

A research program was initiated at the laboratory in 1963 when AEC requested an investigation of the movement and transport of radioiodine through the environment. Radioiodine is one of the pollutants released from nuclear detonations and is readily consumed by dairy cows, leading to contamination of milk.

In its 19-year history, the Las Vegas laboratory has built up a skilled and experienced staff. Its facilities are extensive and highly sophisticated. Much of its equipment is not duplicated anywhere in EPA—indeed, in some cases, anywhere in the world.

## B. Organization

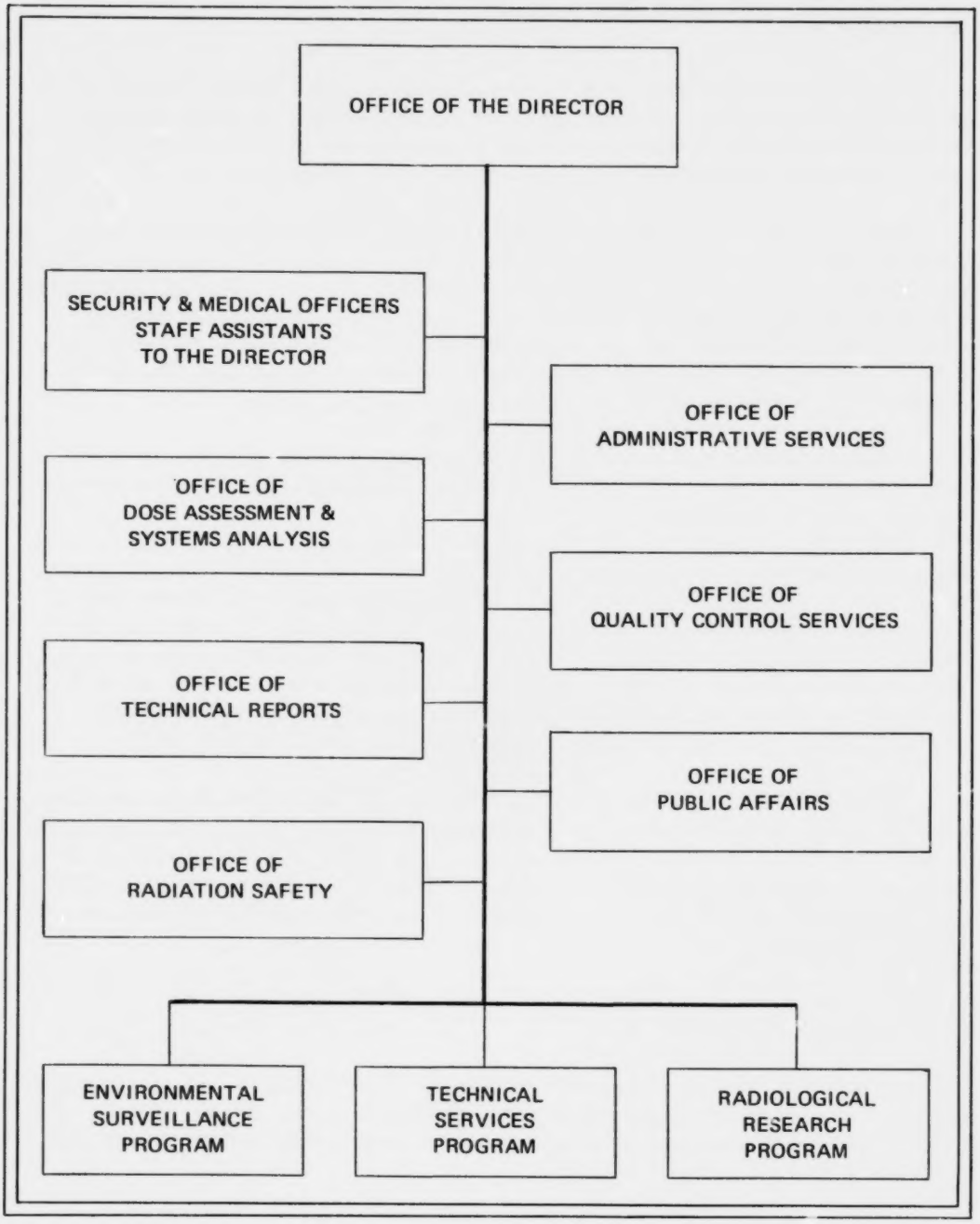
Now that the Las Vegas laboratory has been designated a NERC, ORM assumes the role of landlord, with ORP becoming a tenant. The Office of Planning and Management (OPM) has personnel and financial responsibilities for the center. Positions at NERC-Las Vegas which are currently funded by ORM, ORP, OPM, and AEC are shown in Table 1, while the present organization of the NERC may be broken down into three major line functions and associated staff functions as shown in Figure 2.

Table 1.—Positions Currently Authorized at NERC-Las Vegas by ORM, ORP, OPM, and AEC

| | Permanent | Temporary |
|---|---|---|
| EPA Funded: | | |
| Office of Research and Monitoring (ORM) | 55 | 5 |
| Office of Radiation Programs (ORP) | 35 | 0 |
| Office of Planning and Management (OPM) | 11 | 3 |
| Subtotal EPA Funded | 101 | 8 |
| AEC Funded: | | |
| Off-Site Program | 108 | 0 |
| Radiation Effects | 28 | 0 |
| Animal Investigation | 4 | 0 |
| Subtotal AEC Funded | 140 | 0 |
| Total Center Staffing | 241 | 8 |
| | (=249) | |

FIGURE 2

PRESENT ORGANIZATION OF THE
NATIONAL ENVIRONMENTAL RESEARCH CENTER–LAS VEGAS



The specific programs carried out in each of the line functions are as follows:

*Environmental Surveillance Program.* This organizational component is responsible for: operation of all monitoring networks at NERC-Las Vegas; aircraft operations; the National Eutrophication Survey; support to the Office of Air and Water Programs in the case of oil and hazardous material spills; and projects assigned by ORP, such as the Uranium Mill Tailings Survey.

*Technical Services Program.* The Technical Services Program provides technical support service to all NERC operating programs. This support includes sample control, chemical and instrumental analysis, central data processing and computer programming operations, central electronic services, engineering services, and data analysis.

*Radiological Research Program.* The primary mission of the Radiological Research Program is the investigation of environmental transport processes with emphasis on fission products, although the program has broadened to include other environmental pollutants as well. Some of the major projects underway are: inhalation studies on the carcinogenic effects of specific types of small radioactive particulates; investigations on the uptake, distribution, and effects of radionuclides in cattle and wild animals; and studies of the environmental impact of plutonium.

Under the present organizational structure, personnel assigned to each of the four entities at NERC-Las Vegas (ORM, ORP, OPM, AEC) are intermixed in the above functions.

Two major agreements affect the operations of NERC-Las Vegas. The first is an *Interagency Agreement* between the Director, NERC-Las Vegas and the AEC's Nevada Operations Office. Overall direction for the AEC Interagency Agreement is the responsibility of the Director, NERC-Las Vegas, with the concurrence of the Assistant Administrator for Research and Monitoring. The level and scope of the work required by the AEC are transmitted annually by memorandum to the Director, NERC-Las Vegas. Details of the funding for the approximately 140 reimbursable positions are agreed upon each year. Specific responsibility for the day-to-day operation always resides with the Director, NERC.

The second major agreement is between ORM and ORP and defines the tenant relationship for the ORP programs and ORP positions assigned to NERC-Las Vegas. This agreement set up the position of Assistant Director for Radiation Operations at Las Vegas. He is responsible to the Deputy Assistant Administrator for Radiation Programs for coordination of the tenant ORP programs. Normal administrative services are provided by the Director, NERC-Las Vegas.

### C. Administrative Functions

Operations at NERC-Las Vegas differ from those at other NERC's in that some administrative functions are supported by OPM, some by ORM, and some by AEC, as shown in Table 2. This creates some confusion in management control of the position assignments.

Table 2.–Staffing of Administrative Services by Supporting Organization*

| Function | Total | | ORM | | OPM | | AEC reimbursable | |
|---|---|---|---|---|---|---|---|---|
| | Full Time-Permanent | Other | Full Time-Permanent | Other | Full Time-Permanent | Other | Full Time-Permanent | Other |
| Administrative Office | 3 | – | 2 | – | – | – | 1 | – |
| Personnel Management | 4 | 2 | – | – | 4 | 2 | – | – |
| Financial Management | 6 | 4 | – | – | 4 | 3 | 2 | 1 |
| Procurement | 3 | 1 | 2 | 1 | – | – | 1 | – |
| Personal Property Management | 1 | – | – | – | – | – | 1 | – |
| Facilities Management | 1 | – | – | – | – | – | 1 | – |
| General Services | 13 | 3 | 1 | 1 | – | – | 12 | 2 |
| Total | 31 | 10 | 5 | 2 | 8 | 5 | 18 | 3 |

*ORP does not provide any administrative support positions except through the AEC reimbursable mechanism and therefore is not included in this table.

*Personnel Management.* Personnel management at Las Vegas consists of those activities which must be performed on a day-to-day basis to keep the Center operating. It includes functions such as recruiting and interviewing job applicants; initiating and processing necessary documents (DIPS input sheets, payroll changes, and insurance changes, etc.); answering employee questions on attendance, leave, and benefits; dealing with the local Civil Service Commission offices; assisting program personnel in preparation of job descriptions; formulating and carrying out employee-related programs, such as equal opportunity employment, career development, employee training, and incentive awards; coordinating and preparing necessary personnel reports to EPA Headquarters and Civil Service Commission; and providing appropriate management review and approval of personnel actions, including classification and appointment through Grade 15.

At present, most of these activities are carried out at Las Vegas under general policy guidance received from the Director of Personnel, Headquarters, in Washington. The personnel office at Las Vegas is comprised of four full-time, permanent employees and two temporary employees; they service approximately 250 employees assigned to NERC-Las Vegas and 550 assigned to NERC-Corvallis and its associated laboratories.

*Financial Management.* The Financial Management Office at Las Vegas is a field operation of the Division of Financial Management, Office of Administration, Office of Planning and Management, Washington, D.C. It receives accounting documents, reviews and certifies them as correct, provides payment as required, and enters accounting data into a central computer system. The accounting office provides periodic reports of expenditures to the various Center program directors. These reports constitute the official accounting records of the Agency and are compared with informal records kept by the various program directors. Presently, this operation consists of six full-time, permanent positions and four temporary positions. Control of the positions is provided by the Division of Financial Management in Washington.

*Procurement.* The procurement activities can be divided into two categories: (1) general, those requests which can be directly procured up to a limit of $2,500 and,

(2) advertised/negotiated, those requests (usually above $2,500) that are handled on a negotiated or advertised basis. Presently, NERC-Las Vegas has authority to undertake direct purchases up to $2,500 and to issue GSA contract procurements. Procurements in excess of $2,500, negotiated R&D contracts, and advertised procurements are initiated locally but are then forwarded to the Washington procurement office for processing. Presently, the Center has a relatively small number of contracts—either advertised or negotiated—which exceed the $2,500 limitation. The staffing level for this activity presently consists of three full-time, permanent employees and one temporary employee. Total procurements for both categories are expected to be approximately $1.0 million in FY 1973.

*Personal Property Management.* Personal property management at NERC-Las Vegas consists of maintaining property records on all capitalized equipment within the Center. This includes designating custodial areas, reporting of property records and sending them to Washington, and maintaining a Board of Survey. The Board reviews actions resulting from requests for disposal and equipment lost or stolen and makes appropriate recommendations regarding the disposition of such requests. Part of this job is to maintain necessary contacts with GSA regarding acquisition and disposal of Federal excess property. Presently, there is one full-time, permanent position for this function. EPA Order 1000.5A centralizes the personal property management function in three locations: Cincinnati, Research Triangle Park, and Washington.

*Facilities Management.* The role of facilities management staff at NERC-Las Vegas is to assure that the necessary repairs and improvements are made on the facility in order to provide adequate space and accommodations for the research program. Activities include preparation of plans for modification of facilities, request for new leases when necessary, and development of plans for construction of new facilities. All requests for new construction or major modifications are reviewed in the context of the overall plan for the Center. Presently, one full-time, permanent position is assigned this responsibility.

*ADP Services.* Presently, Automatic Data Processing services are provided from a centralized staff within the Center. The Center has a CDC 1700 computer system with direct access to the CDC 6400 of AEC's Nevada Operations Office. The Las Vegas computer operation supports both the administrative and scientific activities of the Center. Administrative support includes personal property management, personnel, and accounting. Scientific support includes computer systems analysis, statistical analysis, report generation, and data reduction services. Presently, this operation consists of nine full-time, permanent positions. The computer system has extensive capabilities, and it is possible to interface with other large scale computer facilities at other locations with little change in the present configuration. (This function is being transferred from Administrative Services to the Technical Services Program and is therefore not listed in Table 2.)

*General Services.* General services at NERC-Las Vegas consist of such functions as records management; storage and distribution of supplies; warehousing; generation of forms and publications; stenographic and typing support, telephone, facsimile, and other telecommunications services; motor vehicle control; mail and messenger service; scheduling use of facilities; issuing passes; maintaining bulletin boards; graphic support such as printing, reproduction services, and distribution; library services; custodial services and all other required office services which support the programs assigned to the Center. Presently, 13 full-time,

permanent positions and three temporary positions are assigned to carry out these functions.

### D. Research Capabilities

NERC-Las Vegas has earned its reputation over many years in the field of environmental radiation and radiological health. In the past, the emphasis has been on monitoring environmental radiation and studying the transport of radionuclides through the environment. This emphasis has resulted in establishment of many varied and well-equipped facilities, along with a diverse staff of professional and technical personnel. The professional expertise and research capability at the NERC cover the following areas:

- Staffing and personnel skills
- Electronics and shop facilities
- Aircraft fleet
- Collection of field data
- Analytical capability
- Mathematical and systems modeling
- Experimental farm
- Geographic location

In recent years, programs supported at Las Vegas by AEC have declined in size and emphasis, and the laboratory has experienced an overall staffing reduction from 300 at its peak in 1968 to approximately 250 at present, even though some EPA programs at the NERC have increased during the period. These reductions make available to EPA a number of unique, specialized facilities which offer the potential for carrying out environmental research in many key areas besides environmental radiation and radiological health. Because of its varied experience in the radiation areas, the present staff at the NERC offers a diversity of skills and disciplines which can be effectively applied directly to other fields of environmental research. Such applications serve to use EPA's existing expertise at Las Vegas in the most efficient and productive way possible, at the same time that they serve to broaden the scope of the NERC so that it can address environmental research problems on a fully-integrated basis, covering land, water, and air problems in a balanced fashion.

Present staffing at the NERC includes physicists, engineers, chemists, biologists, limnologists, physicians, veterinarians, mathematicians, soil scientists, and ecologists, as well as aircraft pilots, computer technicians, electronics technicians, physical science aids, livestock research helpers, and laboratory equipment fabricators. Table 3 provides a detailed listing of the disciplines of the NERC staff, along with the highest academic degree obtained in their respective fields. This Table includes positions funded by AEC, ORP, and ORM. As is evident from the Table, the Las Vegas staff is particularly strong in engineering, biology, analytical chemistry, physics, and health sciences. It is clear that this capability is well suited to a large variety of monitoring research programs.

The technical and support personnel at the NERC represent over 45 different specialties, including machinists, sheetmetal workers, electronics designers, and photographic specialists. A unique feature of the NERC is its extensive electronics and shop facilities, where

Table 3.—Disciplines and Academic Degrees of the NERC-Las Vegas Staff

| Discipline | BS | BA | MS | DVM | MD | PhD | Total |
|---|---|---|---|---|---|---|---|
| Biological and Agricultural Sciences | | | | | | | |
| Agricultural Science | 1 | | 1 | | | | 2 |
| Biological Science | 4 | | 1 | | | | 5 |
| Botany | 1 | | | | | | 1 |
| Game Management | | | 1 | | | | 1 |
| Marine Science | | | | | | 1 | 1 |
| Physiology | | | 1 | | | 1 | 2 |
| Radiation Biology | | | 3 | | | 1 | 4 |
| Soil Microbiology | | | | | | 1 | 1 |
| Zoology | | | 1 | | | | 1 |
| Engineering | | | | | | | |
| Civil | 3 | | 3 | | | | 6 |
| Electrical | 5 | | 3 | | | | 8 |
| Nuclear | | | 3 | | | | 3 |
| Sanitary | | | 3 | | | | 3 |
| Health Fields | | | | | | | |
| Environmental Health | | | 1 | | | 1 | 2 |
| Medicine | | | | | 1 | | 1 |
| Public Health | | | 1 | | | | 1 |
| Radiation Health | | | 3 | | | | 3 |
| Veterinary Medicine | | | | 2 | | | 2 |
| Mathematical Sciences | 2 | | 1 | | | 1 | 4 |
| Physical Sciences | | | | | | | |
| Biophysics | 1 | | | | | 2 | 3 |
| Chemistry | | | | | | | |
| Analytical | 14 | 1 | 1 | | | | 16 |
| Organic | | | | | | 1 | 1 |
| Physical | | | | | | 1 | 1 |
| Geology | 1 | | | | | | 1 |
| Meteorology | | | 1 | | | | 1 |
| Oceanography | 1 | | | | | | 1 |
| Physics | 2 | | 2 | | | | 4 |
| Other | 7 | 2 | 2 | | | | 11 |
| Total | 42 | 3 | 32 | 2 | 1 | 10 | 90 |

personnel develop, modify, or design special purpose equipment to meet program objectives. These facilities include electronics testing, woodworking, plastic, sheetmetal, steel, and welding capabilities. This capability would be extremely useful in the design of monitoring instruments, in the testing of new state-of-the-art monitoring systems, and in the field evaluation of advanced monitoring techniques.

In addition to the extensive shop facilities, NERC-Las Vegas is unique among EPA laboratories for its fleet of 10 aircraft housed at a nearby aircraft hangar. These planes are utilized in monitoring AEC nuclear tests as well as in the National Eutrophication Survey, where they fly to various lakes in the U.S. and gather data on the biophysical state of these lakes. In addition, these aircraft are used to provide an emergency environmental monitoring capability to other parts of the Agency, such as the Office of Air and Water Programs, in response to leaks of hazardous materials and oil spills. These planes, because of resource limitations and current focus of the programs, are used only about 20 percent of the time. They could be used twice as much without interfering with existing projects. For example, the aircraft could test new and improved remote sensing systems.

Perhaps the strongest single capability of NERC-Las Vegas lies in its extensive experience in field data collection. In addition to its fleet of aircraft, the NERC has designed and outfitted over 20 fully-equipped (portable generators, sampling equipment, 2-way radios, etc.) 2- and 4-wheel drive vehicles as well as a number of trailers which are designed to support studies conducted at remote sites. These units can be moved to various locations to collect monitoring data on a continuous, self-supporting basis. Data handling problems remain to be solved in the mobile sampling field. Also, vibration in mobile units can interfere severely with proper operation of instruments, and requires study. The background and experience of NERC-Las Vegas in designing, building, and operating fully-outfitted trailers and monitoring vehicles is a potential capability which should not be overlooked in any monitoring research programs which evolve in these areas. With such remote monitoring vehicles, it should be possible to collect environmental field data from a large number of monitoring stations and to move these stations in different configurations, comparing the values at each site. Such comparisons offer a potentially useful way to measure the spatial variation of pollutants in air or soil and to gather needed data to determine better ways to locate environmental monitoring sites and carry out sampling procedures. A detailed description of equipment and facilities at NERC-Las Vegas is included in Appendix A.

NERC-Las Vegas, like the other NERC's, possesses an extensive analytical capability, and Las Vegas has some analytical capabilities that are found at none or only a few of EPA's laboratories. In the area of trace metals analysis, for example, the laboratory has expertise in operating X-ray fluorescence and atomic absorption spectrometers. Another unique capability is the operation of automated Technicon-like equipment for chemical analyses. Also, the Las Vegas laboratory's electron microscope and electron microprobe have been used extensively as qualitative tools for identifying constituents of collected aerosol samples. In areas where solid and liquid pollutants must be concentrated to determine low level quantities, the lab has developed expertise in ion exchange and solvent extraction procedures. Las Vegas has also done considerable work in extracting specific gases from air using molecular sieve and vacuum system techniques. Finally, the laboratory has, over many years, developed the capability to isolate very low concentrations of pollutants from air, water, soil, food, vegetation, and tissues. This ability to isolate the pollutants from the remaining

portion of the sample or from common interfering substances in all media cannot be duplicated at many other laboratories.

As a result of these varied techniques, NERC-Las Vegas can undertake almost any type of environmental research monitoring program and be assured of all necessary analytical support.

The field of environmental radiation is rigorous, requiring considerable capability in statistics, physics, mathematics, and the quantitative sciences. As a result, there is considerable potential in Las Vegas to expand into other environmental areas that require mathematical analysis and the processing of large quantities of data. In addition, the Las Vegas NERC possesses a complete computer terminal center with access to a relatively large AEC computer (CDC-6400) at a nearby site. NERC-Las Vegas' competence in statistics and mathematical analysis, combined with the availability of a large computer, makes it well-suited to develop and evaluate mathematical techniques for treating environmental monitoring data in radiation, where considerable emphasis has been placed on development of exposure-dose effects relationships, and in air and water quality as well.

Another unique capability at NERC-Las Vegas is its experimental farm. This facility, which cost more than $2 million to construct, has 20 acres of sprinkler-irrigated cropland, necessary farm machinery for planting and harvesting crops, a 30-cow dairy herd, and over 100 head of beef cattle which graze on surrounding range. The entire farm is in an isolated and highly controlled area where environmental tracer studies can be carried out using toxic materials without fear of harm to local populations. There are few private contractors, universities, or other Federal agencies that have access to an experimental farm that is as extensive and well-equipped. It is an ideal facility for studying the transport and movement of pollutants in the Southwest desert environment from air, water, and soil to plants; from plants to dairy animals; from animals to man. In the past, research at this farm has concentrated on determining the transport of radioiodines from the air to forage crops, to the cows eating these crops, to their milk, and, finally to man. Work has been undertaken recently at the farm on the movement of mercury through the food chain; this research could be expanded to cover other toxic materials without interfering with current activities. The flexibility of this farm permits research in the influence of particle size, type of forage feeding practices, and other parameters on man's ultimate dosage. Such data can be used to develop quantitative models which predict the exposure of man and his environment to various pollutants.

Another feature of importance at NERC-Las Vegas is its geographical location. In its desert setting, the NERC has access to many areas of the Southwest where population is sparse and environmental quality is very high. As a contrast, the NERC also is close to Los Angeles, the Nation's second largest city, which is associated with the Nation's most severe photochemical air pollution problem. Its location close to the Four Corners' Power Plants presents an opportunity for studying the impact of major stationary sources on a relatively pure environment. Thus, in the case of air pollution, the laboratory has ready access to areas having low background pollutant concentrations as well as areas with high man-made pollutant concentrations.

In the case of water pollution, the laboratory has easy access to the waters of pristine quality in the high Sierras, waters of moderately high quality in man-made controlled environments such as Lake Mead (17 miles from the laboratory), and highly polluted waters of California, including the high-salinity waters associated with agricultural runoff of the Imperial Valley. Thus it is easy to collect data in areas that are highly contrasted in terms of environmental quality.

The unique climatic conditions and availability of open land permit field studies under a variety of conditions. Monitoring instruments can be field tested under extreme temperature and operating conditions—ranging from the cold, rarefied air of the mountains to the hot, dry air of the desert—and experiments can be conducted that require large government-reserved land areas. About 1500 square miles of the Nevada Test Site can be made available for carrying out experiments. For example, in this "outdoor laboratory," tracer substances—even if hazardous in nature—can be released under almost any climatic condition, and the ability of new and advanced monitoring systems to measure them can be evaluated. In addition, meteorological diffusion models can be validated under more controlled environmental conditions than normally are possible by making precise tracer measurements of air pollutants. The availability of open area in the desert also makes it readily possible to carry out noise experiments, obtaining good background values free of man-made noise sources and then introducing noises of almost any variety and amplitude. The ability of outdoor materials such as highway walls to absorb sound could easily be tested.

### E. Programs

Monitoring programs presently being carried out at NERC-Las Vegas include: (1) the sampling and monitoring activities conducted for the AEC as part of the Off-Site Radiological Safety Program; (2) aerial surveillance performed in support of operating programs of the Office of Air and Water Programs, the Office of Categorical Programs, the Office of Enforcement and General Counsel, and the Regional Offices; (3) aerial remote sensing and *in situ* monitoring performed in conjunction with the National Eutrophication Survey; and (4) projects carried out in support of the Office of Radiation Programs. Research programs presently underway at the NERC include investigations on the transport and bioeffects of radionuclides as well as studies on the environmental kinetics of nonradioactive pollutants such as mercury and hazardous chemicals such as pesticides.

The program with the longest history at NERC-Las Vegas and one that has provided many significant achievements in environmental monitoring is the Off-Site Radiological Safety Program funded on a reimbursable basis by the AEC. A wide scale environmental sampling program is carried out which includes collecting and analyzing air samples from approximately 100 locations in the U.S. Additionally, water, milk, vegetation, soil, and atmospheric moisture and gas samples are collected and analyzed as necessary to fully document the radiological situation surrounding the Nevada Test Site and other locations where nuclear devices or engines are tested. As part of this program, aerial monitoring and sampling are carried out utilizing specially equipped aircraft.

The knowledge gained by the NERC-Las Vegas staff in utilizing aircraft to follow and sample radioactive effluent released as the result of nuclear testing has been useful in establishing a remote sensing and aerial monitoring capability which is unique in EPA. The

aircraft have been equipped with remote sensing and *in situ* detection or sampling instruments which permit rapid assessment of a pollution problem. The equipment has application in air, water, and terrestrial pollution surveillance. Aerial surveillance is performed in support of operating programs of EPA. Aerial photography, infrared scanning, and airborne pollutant tracking and sampling are typical monitoring techniques applied. Sources of river and harbor pollution are identified, oil spills are mapped, atmospheric pollutants are measured, and other environmental parameters are monitored.

The aerial support capability developed at the Center has been utilized in conducting one of EPA's highest priority programs. This program, the National Eutrophication Survey, was initiated by the President in 1972. In cooperation with NERC-Corvallis, NERC-Las Vegas is to identify U.S. lakes with potential or actual eutrophication problems created by excessive inputs of nutrients, especially phosphates. NERC-Las Vegas aircraft fly over the lakes and use remote sensors to measure chlorophyll-A, temperature, and other parameters. The aircraft then land on the lakes where a variety of *in situ* measurements are taken at various depths in the lakes using contact sensors. Water samples are also collected and analyzed to determine physical and chemical parameters and to determine the extent of eutrophication. The survey will provide information needed to identify lakes which can be improved by reducing nutrient input from waste treatment plants. This information can be considered in awarding grants for construction or improvement of treatment plants.

A number of projects are being carried out at the Center in support of objectives established by ORP:

*Nuclear Facility Study.* This project is designed to determine radiation hazards around nuclear power reactors. Pilot studies have been conducted at the Humboldt Bay plant in California and the Oyster Creek plant in New Jersey. As a part of this project, a special capability is maintained to respond to nuclear emergencies.

*Uranium Mill Tailings.* This project began in 1968 and seeks to correlate population exposure problems associated with the distribution of uranium ore processing sands in the environment. A second part of this study is aimed at evaluating the effectiveness of control techniques used to stabilize tailings piles and to reduce radon gas seepage into indoor areas in buildings constructed upon tailings pile material.

*ORP Monitoring Networks.* A number of environmental radiation surveillance networks were established in the early 1960's when the Center was part of the Public Health Service. These networks include the Pasteurized Milk Network, Institutional Total Diet Sampling Network, Tritium Sampling Network, and Interstate Carrier Water Sampling Network. In addition to these routine networks, a special study, the "Eskimo Surveillance Project," has been conducted by NERC-Las Vegas.

ORP recently terminated the Technical Training Program which has been carried out at the Center for almost a decade. Basic and more complex courses in radiological health have provided training not available outside of EPA (and PHS) to many representatives of State and local health organizations, private industry, and other Federal agencies. Approximately 13 courses per year have been offered at the Center training facilities in Las Vegas.

NERC-Las Vegas is also carrying out AEC-funded research which has added significantly to understanding the mechanisms involved in the transport of radionuclides through the food chain—through soil to plant to animal to man. Major emphasis in AEC's Radiation Effects Program has been on studying radionuclide metabolism in beef and dairy animals and in plants, and studying soil-plant relationships and transport and deposition parameters. Radionuclides of special concern are plutonium, tritium, and radioiodine.

In conjunction with the AEC's testing program, another study is being carried out which is known as the Animal Investigation Program. Bone and other tissue samples from domestic and wild animals in the area surrounding the Nevada Test Site are collected and analyzed. Specific objectives of this work include determination of tissue concentrations of fresh and aged fission and activation products in the animals sampled, evaluation of grazing and migration patterns of wildlife, and evaluation of radioactive effluents on a herd of beef cattle grazing on the Nevada Test Site.

Health effects research is also being funded at the Center by EPA, and two such projects have been in progress for a number of years. One project has sought to determine the combined effect of tobacco smoke and alpha radiation on rat lungs. The second project is directed to the determination of the effect of a single uranium particulate (neutron irradiated) on the rat lung. It will have a significant bearing on the knowledge of the effects of nonuniform exposure to radioactive particulates.

Another EPA-funded research project has been designed to define the precise hazard of tritium. To accomplish this, rabbits are being raised for several generations in a tritiated environment to determine whether concentration or magnification mechanisms occur.

Work has been initiated to study environmental transport of nonradioactive pollutants such as mercury and other heavy metals in a Southwest environment. In attempting to define the rate and character of pollutant transport through various types of soils, the mechanisms involved in the absorption and translocation of the pollutant in soils are being studied. Also under investigation is the role of microorganisms in converting the pollutant into forms which can move readily from the soil to the plant.

A study which has been recently initiated is directed to determining the periods of time a pollutant remains in the environment. This information is particularly important for hazardous chemicals such as pesticides. In order to evaluate short- and long-term hazards, information is needed on the kinetics of environmental pollutants as well as the rates at which such chemicals are degraded or dissipated. This study will also provide information on the toxicity and durability of byproducts resulting from the degradation process.

## CHAPTER III

## ORM ENVIRONMENTAL MONITORING-ORIENTED PROGRAMS

This chapter discusses the nature of ORM monitoring-related programs, with emphasis on unfulfilled research needs in the area of monitoring. To facilitate this discussion, a scheme is introduced to classify ORM monitoring programs within six different areas of activity. Research problems requiring further attention are identified within each of these areas.

### A. Definition of Monitoring

Monitoring is the systematic collection and evaluation of physical, chemical, biological, and related data for the purpose of acquiring knowledge about the state of the environment. This knowledge is used to determine the extent to which man, animals, vegetation, and all other elements of the environment are affected by present and potential pollutants. This knowledge is also used to assess the degree of compliance with promulgated pollutant standards and to define the long- and short-term trends in environmental quality. The data required are obtained from the ambient environment and from point sources.

*Monitoring-oriented, monitoring-related, and monitoring-associated* are used interchangeably in this report to identify all ORM programs that involve, to any significant degree, the collection, analysis, and interpretation of pollution data, and development of techniques to support Agency monitoring activities.

Monitoring-oriented activities in ORM have been subdivided for this report into six Primary Areas of Monitoring Study (PAMS). These subdivisions, originally defined in the document, "An Integrated Nationwide Environmental Monitoring System," prepared by the Office of Monitoring in January 1972, are presented here only to facilitate the detailed analysis of programs within the general areas of monitoring responsibilities assigned to ORM. The six PAMS are:

- Collection of Data in Support of Research Programs
- Development and Evaluation of Monitoring Instrumentation and Methodology
- Development and Demonstration of Criteria for Design of Monitoring Networks
- Development of Techniques for Analysis of Monitoring Data
- Standardization of Sampling Procedures and Analytical Methods
- Development and Implementation of Quality Control Programs for Monitoring

Data in support of research programs are collected to identify the causes, movement, and effects of pollution in the environment. The last five PAMS can be grouped under the general term, "research on monitoring," which is directed toward improvement of sampling and analytical instruments and techniques for monitoring, development of methods to collect representative samples and to ensure their accuracy, and development of better methods to analyze, interpret, and display environmental quality data.

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## B. Primary Areas of Monitoring Study (PAMS) within NERC's

To develop a comprehensive program at NERC-Las Vegas with minimum duplication and overlap, it was necessary to review thoroughly the program content of existing ORM monitoring programs. In this review, major emphasis was directed toward identification of ultimate objectives of on-going research programs and the nature of the research needs which are being met. Thus, the emphasis was on the identification, where possible, of any unfulfilled research needs.

As a beginning step in this review, all monitoring-oriented programs at each NERC were identified. Tables 4, 5, 6, and 7 were constructed which list the on-going, monitoring-oriented program elements performed at each NERC and the PAMS associated with each. Appendix B contains a detailed listing, in alpha-numeric order according to program element number, of the identified ORM monitoring-oriented programs.

The identification of monitoring-oriented program elements was followed by a comprehensive review of the objectives and present and anticipated results of each significant program element associated with each PAMS classification. This review, coupled with examination of current legislation, technical literature, and priority Agency monitoring requirements, identified the most important unfulfilled research needs in each PAMS. These results are summarized by PAMS in the following pages.

### PAMS 1: Collection of Data in Support of Research Programs

Although many research programs use field monitoring activities to collect information, only a few include any large (greater than 25% of total resources) monitoring effort. These are: the Regional Air Pollution Study (RAPS); the Community Health Effects Surveillance Studies (CHESS), fate of pollutant studies on fresh surface waters, ground waters, marine waters, and large lakes; the National Eutrophication Survey; and the special air monitoring networks.

The Regional Air Pollution Study, recently initiated, involves the detailed analysis of the meteorology, air quality, and sources and transport of pollution in the St. Louis region. Data to be used in this assessment will be collected in a coordinated effort utilizing aircraft, mobile laboratories, remote sensing techniques, and an extensive network of stationary air quality and meteorological monitoring stations. Some of the data collection sites will use totally new monitoring concepts, while others will employ routine monitoring methodology. This will permit comparing new and standard methods of sampling and analysis. Parallel studies will collect epidemiological and ecological data for use in relating human health and ecological effects to the documented pollution levels. The physical and chemical pollutant interactions in the atmosphere, the actual pollution levels, and other appropriate physical characteristics of the St. Louis region will be analyzed to develop possible mathematical relationships which will predict pollution concentration distributions over distances on the order of 30 miles.

The results of this study will include: (1) field evaluations of new pollutant sampling techniques, (2) development of criteria for locating sample sites, identification of the proper

Table 4.—Monitoring-Oriented Programs at the NERC-Research Triangle Park

| Program Element No. and Title* | Description of Program Element Activity | Primary Areas of Monitoring Study (PAMS) |
|---|---|---|
| 1A1002 and 1H1325<br>Fuel and Fuel Additive Registration | Registration and analysis of all fuels or fuel additives to be used in assessing the effects of fuel emissions on atmospheric pollution and human health | 1 |
| 1A1003<br>Regional Air Pollution Study | Comprehensive evaluation of air pollution, its causes and effects; development of methods for predicting air pollution levels in metropolitan areas | 1, 2, 3, 4 |
| 1A1005<br>Community Health Effects Surveillance Studies | Determination of the relationships between human health and continuous exposure to air pollution in selected neighborhoods of metropolitan areas | 1, 2, 3, 4 |
| 1A1009<br>Meteorological Research | Development of analytical models to predict air quality from emissions, to evaluate meteorological-air quality relations for enforcement actions, and to evaluate pollution effects on weather, climate, etc. | 1 |
| 1A1010<br>Instrumentation and Analytical Methods Development | Development of methods for measuring ambient air quality and source emissions, including some standardization of these techniques | 2, 5 |
| 1E1079<br>Pesticides Identification Methodology (Perrine) | Development of monitoring methods for determining the extent of human and animal exposure to persistent and biodegradable pesticides, including some methods standardization | 2, 5 |
| 1H1326 (110501 & 502)<br>Advanced Monitoring Techniques | Operation of special air monitoring networks to characterize air pollutants and their levels; laboratory and field evaluation of new and improved commercial ambient air monitoring instruments | 1, 2 |
| 1H1327<br>Monitoring Quality Assurance—Air | Standardization of methods for collecting samples and for operating laboratory and field air monitoring instrumentation; development and implementation of quality control program for air monitoring | 5, 6 |

*See footnote at end of table.

Table 4.—Continued.

| Program Element No. and Title* | Description of Program Element Activity | Primary Areas of Monitoring Study (PAMS) |
|---|---|---|
| 1H1327 Monitoring Quality Assurance—Pesticides (Perrine) | Standardization of analytical methods and measurement techniques for pesticides and implementation of a quality control program; determination of pesticide concentrations and degrees of human exposure | 5, 6 |
| Radiation (Montgomery) | Development and standardization of methods for detection and identification of radionuclides around nuclear power and allied industries; establishment of monitoring networks around these facilities for water, food, milk and air | 2, 5 |

*Some of these program elements are not exclusively devoted to monitoring.

pollutants to measure, and examination of the frequency of pollutant measurement, (3) relationships between human health and pollution levels, (4) effects of pollution on the ecology, (5) an understanding of atmospheric reactions associated with $SO_2$, $NO_x$, hydrocarbons, ozone, organic nitrates, particulates, and aldehydes, and (6) development of mathematical models which assist in predicting pollution concentrations and in developing control strategies.

The Community Health Effects Surveillance Studies program is designed to measure the effects of pollution on selected human populations living within inner-city and other specified neighborhoods. A complex of sampling sites is placed in each neighborhood to accurately measure air and water pollutants, noise, odor, and solid wastes. In many cases, new continuous monitoring instrumentation is used to collect the pollution data. The results of these studies will provide accurate data to develop dose-response relationships for setting environmental pollution standards.

The four different studies on the fate of pollutants in fresh surface waters, ground waters, marine waters, and large lakes involve the identification of sources of pollution in these bodies; the types of pollutants present; the movement, interaction, and modification of pollutants; and the final sinks for the pollutants. This information is obtained from special monitoring programs. Although the *monitoring* effort may be large in some special cases, most of the program effort deals with the critical analysis of the data collected. The data collected are also used (1) to develop mathematical models which predict pollution concentrations and effects on the aquatic systems, (2) to establish scientific criteria for selection of waste disposal sites, and (3) to develop water quality monitoring and management methods.

The National Eutrophication Survey, underway at NERC-Corvallis and NERC-Las Vegas, involves the collection of baseline information on the eutrophic conditions of lakes and impounded rivers which are affected by effluents from sewage treatment plants. The

Table 5.—Monitoring-Oriented Programs at the NERC-Cincinnati

| Program Element No. and Title* | Description of Program Element Activity | Primary Areas of Monitoring Study (PAMS) |
|---|---|---|
| 1B1027<br>Methods Development for Identification of Pollutants | Development of methods for detecting, identifying, and measuring water pollutants, including some methodology standardization | 2, 5 |
| 1B1030<br>Water Quality Implementation Research | Development of new methods and management approaches for collection and transmission of water quality data | 3 |
| 1B2034<br>Combined Sewer Overflows and Stormwater Discharges | Development of new measurement methods on combined sewer overflows | 2 |
| 1B2040<br>Mining Sources | Development of methods to prevent water pollution caused by mineral extraction and mining activities, including some measurement methods development | 2 |
| 1B2041<br>Oil & Hazardous Material Spills (Edison) | Development and standardization of instrumentation and methodology to detect oil and hazardous material spills; establishment of aerial surveillance and interpretation system to find spill threats | 2, 3, 5 |
| 1B2043<br>Treatment Process Development and Optimization | Selection and field evaluation of instrumentation employed in monitoring sewage systems and treatment plants | 2 |
| 1C1046<br>Water Quality Health Effects Research | Development of valid criteria for setting water quality standards for municipal and recreational uses | 1, 2 |
| 1C2047<br>Water Supply Research | Development and evaluation of methods and management practices for the prevention, abatement, and control of pollution in water supplies | 2, 5, 6 |
| 1H1327<br>Monitoring Quality Assurance—<br>Water | Development of standard methods for detecting, identifying, and measuring water pollutants, including the quality control program for water | 5, 6 |
| Radiation | Development, field evaluation, and standardization of methods for determination of radionuclides in liquid and airborne effluents from nuclear power stations and allied facilities | 2, 5 |
| 1R1103<br>Program Management—Research and Monitoring | Development and implementation of a quality control program for potable water supplies | 6 |

*Some of these program elements are not exclusively devoted to monitoring.

Table 6.—Monitoring-Oriented Programs at the NERC-Corvallis

| Program Element No. and Title* | Description of Program Element Activity | Primary Areas of Monitoring Study (PAMS) |
|---|---|---|
| 1B1023<br>Fate of Pollutants in Fresh Surface Waters | Development of a basis, by monitoring and other methods, for predicting and assessing the fate of pollutants entering fresh waters and exposure of humans and aquatic life to these pollutants | 1 |
| 1B1024<br>Fate of Pollutants in Ground Waters | Determination and quantification of, by monitoring and other methods, the fate of pollutants entering and traversing a ground water resource domain | 1 |
| 1B1025<br>Fate of Pollutants in Marine Waters | Determination and quantification of, by monitoring and other methods, the fate of pollutants discharged directly or indirectly into marine waters, including the evaluation of existing field instruments and procedures | 1 |
| 1B1026<br>Fate of Pollutants in Large Lakes | Development of a basis, by monitoring and other methods, for predicting and assessing the fate of pollutants in large lakes | 2 |
| 1B1027<br>Methods Development for Identification of Pollutants | Development of methods for detecting, identifying, and measuring water pollutants, including some methodology standardization | 2, 5 |
| 1B1029<br>National Eutrophication Survey | Quantification of the degree of eutrophication in lakes and impounded bodies of water which receive effluent discharges from municipal sewage treatment plants | 1, 2, 3 |
| 1B1031<br>Eutrophication and Lake Restoration | Development of eutrophication controls and restoration procedures for lakes and ponds, including monitoring guidelines | 1 |
| 1B2044<br>Cold Climate Waste Treatment | Development of cold waste treatment systems, including monitoring and other methods to investigate the tolerances of Arctic aquatic species to various levels of pollution | 1 |

*Some of these program elements are not exclusively devoted to monitoring.

Table 7.—Monitoring-Oriented Programs at the NERC-Las Vegas

| Program Element No. and Title* | Description of Program Element Activity | Primary Areas of Monitoring Study (PAMS) |
|---|---|---|
| 1B1029<br>National Eutrophication Survey | Quantification of the degree of eutrophication in lakes and impounded bodies of water which receive effluent discharges from municipal sewage treatment plants | 1, 2, 3 |
| 1F1083<br>Radiation Pathways Research | Development of information, by monitoring and other methods, on the behavior, movement, and fate of radionuclides throughout the environment | 1 |
| 2F2191<br>Radiation Monitoring | Collection and analysis of radiation pollution samples from all media, including the development and implementation of the quality control program | 5, 6 |
| XF2196<br>AEC Off-Site Radiological Safety Program | Monitoring, in all media, of radiation pollution caused by nuclear explosions | 1 |

*Some of these program elements are not exclusively devoted to monitoring.

field program includes: (1) accumulating and analyzing all available data on the state of eutrophication of the lakes and impounded rivers in the United States, (2) selecting those bodies requiring more data and collecting field samples; and (3) sampling tributaries feeding these water bodies and the effluents from municipal treatment plants along these bodies to assess the total phosphorus input to the lakes and impounded rivers. The sampling program consists of the collection of water samples to be returned to the laboratory for analyses, and physical and chemical measurements at the sampling sites using contact and remote sensors. The results will define the eutrophic levels of lakes and impounded rivers. If a problem exists, the level of phosphorus that can be permitted to enter the lakes and impounded rivers will be defined, and the ability of present control techniques to reduce the phosphorus to the required concentrations will be determined.

Special air monitoring networks are operated throughout the Nation to collect air quality data on those pollutants for which National Air Quality Standards have not been established. Instrumentation at those field sites can range from manual equipment to highly sophisticated continuous air monitoring equipment. The data from these networks are used to assess the atmospheric concentrations of these potentially hazardous pollutants in populated areas. This information forms the basis for establishing air quality standards, for developing control strategies for reducing the pollutant levels entering the atmosphere, and for determining long-term trends in air quality.

Like the general air monitoring networks operated throughout the U.S., many difficulties exist in the special air monitoring networks program. For example, most sampling

stations are located in such a manner that it is impossible to compare pollutant data between sites. In fact, the few sampling sites that are present in a specific metropolitan area are generally so arbitrarily located that measurements obtained are not necessarily representative of the entire area. In addition, the necessary sampling and analytical methodologies have not been developed to sample for pollutants which may be hazardous, such as asbestos.

In summary, these special purpose monitoring efforts support either specific research or field evaluation programs. Except in the case of special purpose air monitoring networks, no gaps can be clearly singled out because of the high concentration of sampling locations and the singular purposes in establishing these networks or sampling locations. The emphasis should be on those new research projects that evaluate monitoring equipment systems or quantify pollution concentrations in the environment.

### PAMS 2: Development and Evaluation of Monitoring Instrumentation and Methodology

Programs to develop, field test, and evaluate uniform EPA methods and instrumentation for monitoring ambient and source pollutant levels, as well as for enforcement purposes, are currently being carried out in the air, water, pesticides, radiation, and oil and hazardous materials areas. To date, the bulk of this effort has been in air and water instrumentation, with the primary research emphasis on development of automated, unattended, *in-situ* instruments and associated laboratory methodology. A lower level of effort has been underway in the other areas. In all media, the field testing and evaluation of automated, remote (i.e., indirect) sensors have not been pursued to any great extent.

The following section reviews ORM programs designed to develop and test monitoring instrumentation in key areas.

*Air.* The development of air-oriented sensors is concentrated in two programs: Program Element No. 1A1010, Instrumentation and Analytical Methods Development; and Program Element No. 1H1326 (110501), Advanced Monitoring Techniques. Both are being carried out at NERC-Research Triangle Park.

Work thus far has produced advances in the detection of particulates, the development of in-stack beta monitors, and the development of mercury and beryllium detection sensors. Programs to validate methods of testing emissions have resulted in effective methods for the testing of light-duty vehicles and some diesel engines.

A major effort is underway in development and field testing of air sensors to monitor ambient levels of $SO_2$, NO, $NO_2$, $O_3$, CO, $CH_4$, and total hydrocarbons. In addition, programs at NERC-RTP have surveyed lead in air, have developed methods for measurement of asbestos and mercury, and have established a calibration program for Continuous Air Monitoring Project (CAMP) stations.

*Water.* Programs for development of water sensors and associated methodology are located at NERC-Corvallis and NERC-Cincinnati. Through the efforts of these programs, laboratory analysis equipment has been automated. In addition, there has been significant

work in development of a computer program for mass spectral matching and an ion exchange liquid chromatograph for automated analysis of pollutants.

There has been some progress in development and testing of automated contact sensors. A modest effort at Cincinnati has led to a remote data collection platform with a tie to the Nimbus satellite. This program provides for automatic sensing, recording, and transmittal of five to eight parameters from the sampling site to the satellite, where it is in turn transmitted via NASA/Lewis to NERC-Cincinnati for analysis. The use of aerial surveillance for detection of oil spills was demonstrated in FY 1972. The program included the use of photography, spectral imagery, and first-generation IR and UV remote sensing systems.

*Pesticides.* A small program of sensor development is currently being carried out at the Primate and Pesticides Effects Laboratory at Perrine. The major effort has been to improve analytical techniques. A parallel effort has provided for the modification and adaptation of manual methods to automated gas chromatographic-mass spectometric methods. Noncontact and contact sensor systems that will reduce the degree of manual sampling required for pesticides will be developed in future programs.

*Radiation.* A modest budget has restricted the development of new and improved sensor systems for radiation. Work to date has concentrated on development and evaluation of methodology to measure radionuclides. It is anticipated that future sensor efforts will be aimed at increasing sensitivity and establishing sensor networks.

In this review of sensor development, it is evident that only a few automated contact and noncontact sensors have been field tested. The primary effort has been to advance the state-of-the-art of laboratory testing procedures rather than to investigate the automation of field sampling procedures.

### PAMS 3: Development and Demonstration of Criteria for Design of Monitoring Networks

The description of programs associated with special purpose monitoring activities in support of research (PAMS-1) includes a discussion of the Regional Air Pollution Study (RAPS). RAPS is the only program where any large-scale effort has been directed toward development of criteria for the design of air monitoring networks that can *accurately* define existing pollution levels. Some of the criteria to be developed include: (1) location and density of sampling sites to collect representative samples; (2) types of pollutants on which data must be collected and analyzed to assess the pollution burden of the region; (3) the frequency of pollution measurements required; and (4) the physical characteristics of the environment which must be monitored, to more accurately quantify health and ecological pollution effects, standards compliance, and baseline trends and conditions.

A real and widening gap exists between the quality of information available from monitoring networks and the complex and costly control decisions EPA must make based on that information. In the air monitoring program, for example, it is impossible to compare the air quality of two cities using existing data because there are no standardized criteria for selection of sampling sites. There are not enough stations within a given region or nationwide to supply statistically accurate data on air and water quality.

Another important gap is that all monitoring networks now operating collect samples only within their own medium or else look narrowly at only specific pollutants in the total environment. No program currently is directed at looking at total environmental exposure to all pollutants, regardless of the medium in which they occur.

### PAMS 4: Development of Techniques for Analysis of Monitoring Data

Except in isolated portions of ORM programs, little effort has been made to advance data handling methodology much further than the basic concepts embodied in the STORET and NADIS programs. Their main purpose is to store and retrieve monitoring data. For the most part, they conduct relatively low-level, routine statistical analyses that are not rigorous from a mathematical standpoint. There is little emphasis within ORM on development of statistical models which comprehensively utilize environmental pollution data, physical characteristics of the environment such as meteorology and topography, population densities, human health patterns, transportation patterns, or raw materials usage to *quantitatively* assess pollution in the environment. Research is now underway to develop meteorological diffusion models for air and models for water basin planning, but these efforts are limited to the physical aspects of the problem, such as the transport of pollutants from sources to receptors.

Presently, environmental pollution assessments are done on a pollutant-by-pollutant or single medium basis, instead of determining the combined, or synergistic, effects of pollutants in all media on man. Even when an effort is being made to combine actual, measured pollution levels with physical characteristics of the environment, the effort is not extensive and does not draw from the data all possible comparisons and underlying relationships. In developing control strategies for eliminating or reducing environmental pollution, only a *qualitative* approach has thus far been emphasized in relating current and future pollution levels to parameters such as transportation patterns, human health patterns, and raw material usage.

### PAMS 5: Standardization of Sampling Procedures and Analytical Methods

Standardization programs are currently in NERC-Research Triangle Park (air), NERC-Cincinnati (water, radiation, and solid waste), the Primate and Pesticides Effects Laboratory at Perrine (pesticides), the Eastern Environmental Research Laboratory (radiation), and NERC-Las Vegas (radiation). At present, no work is underway in noise. Most of the Agency's standardization programs have been centralized under Program Element No. 1H1327. There are several other program elements which contain some peripheral standardization activities.

*Air.* In air, EPA reference methods have been promulgated in conjunction with nine source and environmental standards. Testing to validate the methods is currently going on at NERC-RTP and by contract. Work thus far has verified four pollutant measurement methods as reliable; one method is still being tested and one is deficient in its present form. Testing of measurement methods is beginning for another three pollutants. However, an additional 25 pollutants found in a wide range of locations, sources, and concentrations

have been identified as potential pollutants for ambient and source standard-setting activities, and this will require standardization of sampling and analytical methodology.

*Water.* Water monitoring methods can be divided into physical-chemical, biological, microbiological, and sedimentary measurement methods. In 1971, 68 physical-chemical procedures, which for the most part have been thoroughly evaluated and collaboratively tested, were published by NERC-Cincinnati. In mid-1973, 50 biological methods will be published by NERC-Cincinnati as tentative methods. Approximately 20 analytical methods for sediments have been proposed as candidate methods; microbiological methods have been developed but require further standardization.

The new water legislation specifically identifies new monitoring requirements, so future work on the standardization of sampling procedures and analytical methods must be undertaken, especially in the sediment, biological, and microbiological areas.

*Pesticides.* A pesticide manual containing 44 tentative standard analytical methods was developed in January 1971; it is being updated and revised for issuance shortly. Since the gas chromatograph is the primary analytical tool, efforts in standardization have focused on developing standard analytical procedures for sample extraction, preparation, and cleanup processes. Using silica gel as column packing instead of Florisil may broaden the range of pesticides detectable with the overall gas chromatographic process, but routine use of silica gel is a few years off. The Primate and Pesticides Effect Laboratory in Perrine is evaluating and testing procedures for determining PCB in human tissue, standardizing the analytical procedures for pesticides in air, and controlling the quality of certain analytical materials used in laboratories. Perrine has also begun developing computer controlled techniques for sample injection and data analysis. Standardization procedures are being developed for the operation of computer-assisted gas chromatographs and mass spectrometers.

*Radiation.* Twenty radiation monitoring methods were published in 1967. Some have been collaboratively tested, five have been published in *Standard Methods,* and three more are being evaluated now. Most of the present standardization effort is carried out at NERC-Cincinnati, the Eastern Environmental Radiation Laboratory, and NERC-Las Vegas and is closely associated with instrumentation development and quality control efforts.

*Solid Waste.* Air and water sampling and analysis methods cannot be employed directly in monitoring solid wastes because of unique interferences caused by certain substances in the refuse, residue, or effluents. Major procedural modifications are required if measurements are to be accurate. Eighteen candidate methods have been proposed, mainly for analyzing refuse and residues. Most of the effort in FY 1972 was spent on methods for analyzing leachates and effluents.

*Noise.* With enactment of new legislation, noise emission standards and the associated measurement methods are required.

In this review of the standardization activity it is evident that too little development and testing of standard sampling procedures is occurring because of resource restrictions. With the limited resources available, each activity has been able to develop some tentative standard methods but has not been able to fully evaluate the methods and collaboratively test them.

### PAMS 6: Development and Implementation of Quality Control Programs for Monitoring

Quality control programs are currently operating in air, water, pesticides, and radiation. Solid waste and noise lack fully operational programs. The level of effort varies within and among these programs. The effort in air is centralized at NERC-RTP; water at NERC-Cincinnati; pesticides at the Primate and Pesticides Effects Laboratory at Perrine; and radiation at NERC-Las Vegas. Most of the Agency's quality control activity has been centralized under Program Element No. 1H1327. However, quality control procedures are also being developed in certain other program elements.

*Air.* The air program at NERC-RTP began in January 1972. Currently, it is developing standard reference materials for gases and delivery systems designed to generate standard reference samples. The program is preparing to issue quality control manuals for field and laboratory operations and an inter-intra-laboratory quality control program.

*Water.* The quality control activities in water have been developed mainly by three groups. The Analytical Quality Control Laboratory at NERC-Cincinnati has been preparing and providing standard reference samples to water laboratories throughout the country. In 1971 it prepared an intralaboratory quality control manual. The laboratory also evaluates the quality of analyses among the field labs and provides technical assistance to field water labs when requested. The Water Supply Programs Laboratory at NERC-Cincinnati supplies standard reference samples to State laboratories performing analyses on drinking water; it also participates in a certification program for State bacteriological and chemistry laboratories. The third group, the Consolidated Laboratory Services at NERC-Corvallis, has developed a model intralaboratory quality control program, including a system for verifying laboratory data and managing the flow of samples through the laboratory.

*Pesticides.* The pesticides quality control program, centered at the Primate and Pesticides Effects Laboratory, has developed inter- and intra-laboratory quality control procedures, continually prepares and distributes standard reference samples to State laboratories and other EPA labs, and has developed a repository of standard reference samples for other Government agencies to use. Because of limited resources, quality control manuals have not been prepared, and the quantity of standard reference samples is inadequate to meet Regional needs.

*Radiation.* The radiation quality control program is located primarily at the NERC-Las Vegas. This program provides EPA and other laboratories with standard reference samples, carries out "cross-check" sample studies between labs, and provides technical assistance in developing quality control programs in EPA laboratories. In addition, NERC-Las Vegas has developed a model intralaboratory quality control program which includes a data handling system that minimizes laboratory errors.

Although each program has its own priorities, more interaction could be developed among the groups. There are presently not enough resources (1) to produce and distribute standard reference materials and samples to meet the Regional requirements, (2) to establish and maintain a certification program for EPA-associated laboratories, and (3) to provide technical assistance in developing intralaboratory quality control programs. Because of limited resources, the radiation program has not prepared any quality control manuals; nor can the program now provide adequate technical assistance to the Regions.

In the quality control programs described, little effort has been made to develop quality control procedures for field sample collection. There is no quality control program in solid waste monitoring. As noise monitoring becomes operational, a quality control program must be concurrently established. Only a few EPA laboratories have a strong intralaboratory quality control program.

## CHAPTER IV

## RECOMMENDATIONS FOR PROGRAMS, ORGANIZATION, AND FACILITIES

This chapter presents recommendations for the programs, resources, organization, and facilities at NERC-Las Vegas. It first identifies seven key research and monitoring program areas that can be established at NERC-Las Vegas to provide a solid base for the NERC's research program, consistent with its theme. It then describes the transfers of function and positions that would be necessary to make initial progress in achieving an FY 1974 adequate program. It discusses the general organizational structure and administrative service arrangement which should evolve at the NERC, and finally, it outlines various alternatives to meet the need for future facilities at Las Vegas.

### A. Project Areas for NERC-Las Vegas

In the previous chapter, monitoring-oriented programs underway at the NERC's were classified, according to the nature of their activities, into six Primary Areas of Monitoring Study (PAMS). These programs then were critically reviewed in an effort to identify highest priority unfulfilled research needs in the monitoring area.

In this chapter, an effort is made to respond to these needs—within the context of the professional expertise, geographical features, unique facilities, and specialized equipment at NERC-Las Vegas—and to identify specific NERC Project Areas (NPA's) which could best be performed at NERC-Las Vegas. NPA's, in this report, represent unique functional areas of activity concentrated at a particular National Environmental Research Center. Classifying NERC projects by NPA's was found necessary because ORM now has no convenient classification scheme for uniquely identifying project areas with a particular NERC. Because PAMS are general program categories, useful only for classification purposes, the NPA's frequently can be grouped under more than one PAMS, depending on the breadth of the latter.

The seven NPA's identified in this chapter are intended to provide a firm research and monitoring base consistent with the environmental monitoring theme of NERC-Las Vegas. These may be viewed as general areas of activity within which specific projects at the NERC can evolve. It is the role of the Program Coordination Office of NERC-Las Vegas, in conjunction with Headquarters, to establish projects within NPA's which fully and effectively utilize available resources at the laboratory. It should be noted that the following NPA's are not presented in any particular order, and the question of the priority of each NPA is a program planning decision. One of these areas, NPA No. 2 (Aerial Surveillance Support), is an operational monitoring activity in which data are collected for technical assistance and enforcement purposes. This is the only NPA which does not have a major research component.

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The seven NPA's identified as appropriate for assignment to NERC-Las Vegas are as follows:

1. Special Staff Studies
2. Aerial Surveillance Support
3. Development and Field Testing of Aerial Remote Sensing
4. Biological Monitors of the Environment
5. Development and Field Testing of Noise Monitoring Instrumentation
6. Development and Demonstration of Monitoring Networks
7. Development of Data Interpretation Techniques

The following sections describe each of these NPA's at greater length, indicating selected examples of possible projects which could be undertaken within each area.

## NPA 1. Special Staff Studies

Special staff studies should consist of detailed reviews, in publishable report form, of the state-of-the-art of our knowledge in key monitoring-oriented areas. These reviews may be derived from in-house literature searches, or they may be developed from extensive use of task forces, committees, and contractors. Their chief purpose is to focus research questions more clearly. Reviews may be undertaken on a pollutant-by-pollutant basis—for example, a staff study may examine the state-of-the-art of monitoring of environmental lead—or they may focus on specific monitoring problems of a broader nature.

These reviews will examine and bring together pertinent reports dealing with essential aspects of monitoring prepared by the operating program offices (OCP, OAWP, OEGC, The Regions) and will evaluate the outputs from ongoing research programs related to monitoring. Selection of priorities for special staff studies will be coordinated with the Office of Monitoring and the Office of Research. These reviews should summarize existing knowledge and determine, in detail, the nature of any needs and gaps. A major part of this effort should be completed within the first 2 years of its initiation (FY 1974-75). Since these studies should be long-range in nature, they should emphasize the Agency's research monitoring needs on a 5- to 10-year basis, requiring only minor "updating" thereafter.

The following project is an example of a possible special staff study:

### PROJECT EXAMPLE

Purpose:

The purpose of this work is to bring together basic information on monitoring network activities in the United States to assist in development of criteria for Agency monitoring strategies. The result will be a detailed data base that gives an overview of the national environmental monitoring effort.

Discussion:

An initial review of EPA's monitoring network activities reveals considerable lack of consistency in various urban areas. In some cities, for example, drinking water is monitored routinely but milk is not; in others, milk is monitored but food is not; in still others, air quality is monitored but radiation is not. By extending this analysis further, showing the individual pollutants monitored and the sampling techniques employed, it should be possible to gain needed insight into the problems of developing a coordinated national surveillance strategy.

Description:

A complete assessment will be made of national monitoring networks operated by EPA, other Federal agencies, and State and local agencies. This assessment will examine data collection networks in all media and "routes of exposure," including air pollution, radiation, pesticides, drinking water, recreational water, food, and milk. Tables will be prepared showing the individual pollutants which are monitored in all locations of the United States, and statistical summaries will be compiled giving the distribution of sampling activities throughout the Eastern and Western States, the degree to which monitoring activities are coordinated in individual locations, the consistency of sampling methodology, and costs associated with various network monitoring approaches throughout the Nation.

*Recommendation: The research program at NERC-Las Vegas must be both substantive and well balanced, covering the areas of land, water, and air in an integrated fashion. To move toward this goal, it is recommended that NERC-Las Vegas be given the responsibility to develop special staff studies. Some can be carried out by contracts and grants. These studies also can be carried out as joint projects with other NERC's, other Federal agencies (the AEC and National Academy of Sciences, for example), EPA committees, and university consultants.*

NPA 2. Aerial Surveillance Support

In the past, the aerial surveillance capability of NERC-Las Vegas has been made available to other parts of EPA. The Oil and Hazardous Materials Division of OAWP uses this aerial capability to assist in monitoring activities during environmental emergencies such as oil spills or leaks of hazardous materials. The National Eutrophication Survey complements its ground-based data with contact and remote sensing monitoring data from Las Vegas helicopters. In radiation monitoring, fixed-wing aircraft are equipped with radiation counters and sample collection devices for use in variable altitude monitoring.

High priority monitoring projects which can effectively be carried out by aerial surveillance and which directly support the EPA monitoring operating programs include:

- Reconnaissance surveillance to locate all waste sources contributing to pollution in the monitored area and to identify where to collect the most representative samples and how to gain access to these locations. Most of this would involve aerial photography and aerial observation.
- Collection of water samples for a variety of monitoring purposes in large bodies of water where routine methods (boats) are unfeasible or in any water body difficult to get to by land (as in the National Eutrophication Survey).

While the NERC's aircraft can easily reach most destinations in the West within a relatively short time, the flight time to locations in the East—particularly New England—is usually too great for most emergency applications, and there appears to be a real need for a similar aerial surveillance capability in the eastern part of the United States near major bodies of water.

The following project is an example of possible work in the area of aerial surveillance support:

**PROJECT EXAMPLE**

Purpose:

The purpose of this project is to enhance the emergency response capability of NERC-Las Vegas by assuring that the laboratory is equipped to provide extensive environmental monitoring services on a quick response basis, including the use of airplanes, helicopters, tractors, vans, and other mobile monitoring equipment. The intent is to give needed support to other parts of EPA (OAWP, The Regions, etc.) during events such as accidents involving hazardous air or water pollutants, and to carry out short-term monitoring during air pollution episodes, data collection and monitoring of oil spills, measurement of environmental effects during natural disasters, and any other short-term monitoring projects requiring unique or specialized equipment not available elsewhere in the Agency.

Discussion:

EPA has a significant role to play in environmental emergencies, as exemplified by the activities carried out by the Oil and Hazardous Materials Division of OAWP. EPA's data collection efforts during such emergencies can be seriously impeded if the equipment does not arrive promptly, and, in some cases, data collection cannot proceed at all without the use of airplanes and other special vehicles. It is unreasonable for each EPA Regional Office to equip, maintain, and operate its own fleet of aircraft, and thus there is considerable advantage to using and enhancing the services provided by aircraft and other unique facilities EPA already owns in Las Vegas.

Description:

A review currently is being compiled by EPA of the major environmental emergencies to which government agencies have had to respond in the last 5 years. All equipment, instruments, and staff needed to cope with such emergencies will be made ready at NERC-Las Vegas. The goal will be to respond to emergencies anywhere within the western United States within 2 to 7 hours. Communication links with each Region will be established, and the Regions will be made fully aware of the Center's complete capabilities by means of special manuals, brochures, and technical demonstrations. There will be coordination with the EPA Emergency Coordinator, Office of Planning and Management, and the Emergency Response Team Leader on all phases of this work.

*Recommendation: The aircraft fleet of NERC-Las Vegas is unique within the Agency and serves an important EPA support function. It should be maintained, and, where necessary, expanded to meet the needs of the emergency and surveillance activities of EPA, including the development of a possible "satellite base" in the Great Lakes area or the Northeast. Candidate locations to be considered might include the EPA-owned Grosse Ile Laboratory in Michigan or EPA's Edison Laboratory in New Jersey. It is recommended that*

*a study be undertaken of possible locations and costs and that a program element be designated for use of aircraft and associated personnel as part of the emergency response capability of EPA.*

NPA 3. Development and Field Testing of Aerial Remote Sensing

Aerial remote sensing concentrates on the design, development, testing, and evaluation of remote instruments and techniques mounted on aircraft, including spectrometers, radiometers, lasers, interferometers, conventional continuous sampling instruments, advanced photographic techniques, and other state-of-the-art devices. Research on aerial remote sensing techniques would take advantage of the fleet of aircraft at NERC-Las Vegas, as well as the capabilities of the staff and support personnel, including the workshop and electronics staff.

Many remote sensing instruments have already been developed as laboratory tools or as field measurement devices for nonpollution applications. The main thrust of the laboratory and field evaluation program at NERC-Las Vegas should be to take promising prototypes and modify them for specific pollution monitoring needs. These techniques may include, for example:

- lasers (Raman scattering) (for measurement of $SO_2$, $NO_2$, and particulates)
- microwave radiometers (for measurement of oil at sea and temperature of the sea surface)
- laser fluorometers (for measurement of oil, chlorophyll, and algae)
- nondispersive infrared spectrometers (for measurement of CO and $CO_2$)
- differential radiometers (for measurement of chlorophyll and algae)
- derivative spectrometer techniques (for measurement of $NO_2$ and $SO_2$)
- Frauhofer line discrimination techniques (for measurement of oil and the dispersion characteristics of effluents)

Since much information can be obtained from sophisticated monitoring instrumentation, interpretative techniques such as color enhancement and computer processing of incoming data signals should be developed to identify less pronounced readings. Because of the savings in cost, unattended automatic *in situ* sensor monitoring packages also should be developed, and NERC-Las Vegas should develop data relay systems for these unattended sensors.

As more remote sensing instruments are developed inside and outside EPA, it will be necessary to define which combinations of remote instruments should be used to measure pollutants more accurately. Such "packages" of instruments should be designed for use in fixed and rotary winged craft.

The following project provides an example of research studies that could be carried out using the NERC's remote sensing field capabilities:

**PROJECT EXAMPLE**

Purpose:

The purpose of this work is to compare indirect, remote instrumentation with fixed-point sampling and with mobile sampling. From this work, it will be possible to determine how the remote sensors now available can be effectively utilized to monitor environmental pollution.

Discussion:

Much progress has been made in perfecting remote instrumentation techniques, such as the Barringer correlation spectrometer designed to measure $SO_2$, $NO_2$, and oxidant over finite path-lengths. A major problem in the utilization of these approaches, however, is the need to establish their compatibility with conventional techniques and the need to show how they can provide useful measures of environmental quality not available by ordinary means.

Description:

Detailed studies will be made of various remote instruments, such as the Barringer spectrometer, to establish the validity of their data in relation to conventional ambient point sampling techniques. Primary emphasis will be upon establishing how such remote instruments can be used in the field—separately or in conjunction with conventional instruments—to implement air quality standards and, where applicable, water quality standards. Data will be generated to establish the comparability and validity of the two approaches—remote sampling and point sampling—and demonstration programs will be undertaken, in an actual urban area, to determine the effectiveness, applicability, costs and benefits, and practicability of remote sensing in the field. Results will be compared with those obtained from mobile platform sampling.

*Recommendation: At present, Las Vegas aircraft are underutilized, and it is estimated that their utilization could double without interfering with other programs which now make use of the aircraft. Because of the uniqueness of these facilities at Las Vegas—the aircraft fleet and its support facilities—as well as the previous experience of the staff in aerial data collection activities and the availability of instrument fabrication support, it is recommended that all EPA research on remote sensing by means of aircraft be concentrated at NERC-Las Vegas. Feasibility studies involving remote sensing from other mobile platforms such as satellites also should be concentrated in Las Vegas.*

NPA 4. Biological Monitors of the Environment

Research on biological monitors of the environment concentrates on the detection and measurement of pollutants in the biosphere using biological systems as monitoring devices. By drawing upon data which appear in the literature as well as the research findings from other NERC's, this research area will identify elements of biological systems which have appropriate "response" characteristics to serve as biological monitors of selected environmental pollutants. The investigations employ both field and laboratory studies to examine the specificity, accuracy, precision, interferences, and kinetics of uptake and excretion in these biological systems. The use of radioactive tracer materials is a valuable adjunct in determining the responsiveness of the systems to low concentrations of environmental

pollutants. Also, tracers afford a powerful means of determining exposure-dose-effect relationships.

The following project is a sample of possible work in this program area:

**PROJECT EXAMPLE**

Purpose:

The purpose of this research is to develop routine methods for using biological monitors to assess the exposure and accumulation of toxic materials in the biota.

Discussion:

Despite the known hazards associated with various toxic substances—mercury, arsenic, lead, beryllium—little is known about the levels of these substances in plants and animals or the extent to which current levels differ from levels existing many decades ago. This research is responsive to the overall charge given to the Agency to measure and assess the true exposure of man and the environment to pollution. It draws heavily on the Las Vegas capability to accurately measure and detect extremely low concentrations of pollutants utilizing plants and animals as monitors of these pollutants.

Description:

Methodologies will be developed for collecting routine data on the accumulation of pollutants by plant and animal systems. This information will be used to determine the increases or decreases of toxic materials—for example, lead, mercury, arsenic—in the tissue of various plant and animal species. Sources of the data include tissue samples, blood sampling surveys, and analyses of excreta; data collection should cover livestock, wildlife, and plants.

*Recommendation: Because of the substantial experience of NERC-Las Vegas with radioactive tracers, and because of the highly controlled conditions available at the experimental farm, it is recommended that development, testing, and evaluation of new biological monitoring techniques and methodology form a substantial part of the NERC research program.*

NPA 5. Development and Field Testing of Noise Monitoring Instrumentation

Research at NERC-Las Vegas on noise monitoring techniques would deal with the development and standardization of new methods for routinely monitoring noise in urban areas. This includes evaluation and refinement of noise-sensing devices and procedures, development of methodology for conducting noise surveys in cities, and publication of guidelines on various ways to monitor environmental noise in cities. The first step in this work would be to assess the noise monitoring devices available and to determine what research and development is required. If existing noise monitoring instrumentation is satisfactory, then standard measurement methodologies should be developed to ensure accurate and reproducible test results. This would include techniques for weighing and averaging noise measurements with respect to their occurrence, duration, intensity, and pitch. Research on the health effects of noise would, of course, be carried out at NERC-Research Triangle Park. Likewise, research on control technology for noise would be conducted at NERC-Cincinnati.

The following provides an example of a possible project in this area:

**PROJECT EXAMPLE**

Purpose:

The purpose of this research is to develop monitoring techniques and methodology that will allow judgments to be made as to the magnitude and nature of urban noise levels, typical noise exposures in urban areas, and the factors which most seriously influence noise levels.

Discussion:

The major goal of this effort is both to fulfill a research need and to provide EPA with considerable technical expertise in the area of noise measurement and monitoring. This project will be closely coordinated with work underway at the National Bureau of Standards.

Description:

Research will be undertaken, in conjunction with the Office of Noise Abatement, to develop techniques for the proper surveillance of noise in urban areas. Field studies will concentrate on development of the proper methodology by which to use noise instrumentation to measure urban sound levels, random sampling with portable instrumentation, mobile sampling in traffic, and measurement of excessive exposure by selected members of the urban population.

*Recommendation: Because of the monitoring theme at NERC-Las Vegas, the considerable expertise of the staff in making field measurements, and the broad capabilities in instrument fabrication, electronics, and shop work, it is recommended that noise monitoring projects be concentrated in NERC-Las Vegas.*

NPA 6. Development and Demonstration of Monitoring Networks

Research on the development and demonstration of monitoring networks refers to studies directed toward the development of networks for the measurement of long-term environmental trends, standard setting and compliance progress, and the true exposure of humans and other elements of the environment to various pollutants. It includes the planning and implementation of advanced networks to measure, in a comprehensive fashion, the true exposure of members of the population to specialized pollutants such as lead. It also includes the development and demonstration of new methods of collecting monitoring data, such as the use of aircraft in conjunction with mobile sampling units, the use of remote sensing instruments in conjunction with ground-based stations, and the use of personal environmental monitors of exposure. The work concentrates on the development, demonstration, and advancement of any and all data collection methods which can be used to better quantify the exposure of man, plants, and animals to environmental pollution. It develops improved ways to determine the manner in which various pollutants reach populations at risk, develops methods to assess the costs and effectiveness of existing monitoring approaches, and develops techniques for evaluating optimal monitoring strategies for the Nation. Research in this project area covers the planning of monitoring data collection, the demonstration of monitoring methodology, and ultimately, the development of criteria for monitoring network design. The goal is to determine how to efficiently, effectively, and representatively monitor a particular pollutant throughout the environment, or a series of pollutants within a medium, to accurately quantify environmental quality.

The following is an example of one possible project in this area:

**PROJECT EXAMPLE**

Purpose:

The purpose of this work is to develop better ways to monitor the environmental quality of large physical areas, such as cities, with greater efficiency and effectiveness and with a possible savings in cost.

Discussion:

Although some studies have been done using vans and airplanes to collect air quality data, these have been piecemeal efforts, and there never has been a concerted effort to perfect these techniques or to demonstrate their capabilities in routine environmental monitoring. It is possible that, if perfected, new and more useful environmental assessments could be made at less cost than with existing methods. This work will be coordinated with the RAPS study in St. Louis and with field efforts underway in other parts of the country.

Description:

Specialized studies are to be undertaken to determine the feasibility and capability of using mobile platforms to gather comprehensive data for assessing environmental quality. Research will include the development, testing, and evaluation of vans and motor vehicles equipped with shock-mounted instruments for measuring air quality ($CO$, $NO_x$, oxidant, hydrocarbons, $SO_2$) while driving on selected routes through urban areas. Special data systems will be developed to integrate monitoring data with information on the vehicle's coordinates and position to produce maps showing pollutant concentration along the route and pollutant contours over the area. Allied studies will be conducted using advanced instruments in airplanes to measure concentration profiles at different heights. Special-purpose instruments will be developed and tested for use in these aircraft. Resulting data will be compared with remote sampling results, and detailed information will be developed on the costs, effectiveness, and advantages of sampling by mobile versus fixed stations.

*Recommendation: Because this work is not receiving emphasis on a multimedia basis, because of the NERC-Las Vegas experience in collecting large quantities of field data, because of its computational capability, and because of its monitoring theme, it is recommended that development and demonstration of monitoring networks receive considerable emphasis in the expansion of the NERC-Las Vegas programs.*

## NPA 7. Development of Data Interpretation Techniques

Development of data interpretation techniques includes application of analytical approaches such as decision analysis, time series analysis, linear programming, dynamic programming, and stochastic modeling in the context of monitoring problems. Particular emphasis would be placed on multimedia approaches in the development of improved mathematical and statistical techniques for the analysis, interpretation, and display of environmental quality data; development of improved exposure-dose-effects models, urban pollutant projection techniques, averaging-time-concentration-response models; refinement and promulgation of confidence interval estimation techniques; development of computer graphics packages; application of optimization techniques to key components of monitoring problems; and the development and refinement of other numerical methods that can be of assistance in evaluating and interpreting environmental quality data. Particular projects

might, for example, involve development of a system of equations for the optimal placement of monitoring stations on a spatial plane with known concentration gradients (to be coordinated with RAPS) and application of time series analysis to the problem of forecasting diurnal pollutant concentrations. This work is intended to be rigorous and to establish a firm base of quantitative techniques development, applied to monitoring problems, within EPA. It will result in the publication of analytical manuals indicating how to apply these approaches, as well as technical articles, computer packages, and users' manuals. This work will be closely coordinated with other modeling efforts underway elsewhere in the Agency.

An example of one possible research project in this area is as follows:

**PROJECT EXAMPLE**

Purpose:

The purpose of this research is to develop better methodologies to project the magnitude, extent, and geographical distribution of environmental pollution problems into future years. Availability of natural resources will be examined in relation to projected problems.

Discussion:

Although there has been considerable discussion about the need for improved projection methodologies, EPA's present efforts are piecemeal and are not sufficiently rigorous to promise to advance the state-of-the-art. This program would consolidate, in one effort, an in-depth treatment of environmental data, with particular emphasis on mapping and projection methodology. This project will be coordinated with the network design and demonstration effort (NPA #6).

Description:

New and improved approaches will be examined for the computer collection, processing, and display of environmental pollution data. These will include development of methodologies to facilitate analysis of air pollutant emissions and concentrations in relation to urban growth, water resources, and energy reserves. Pollutant emission data will be analyzed and processed, and various maps will be generated and compared, by computer, with population density maps, resource maps, and geophysical boundary maps. Spatial area correlations will be examined, and new and advanced quantitative methodologies will be developed to project future increases or decreases in environmental problems. Base data will include population, economics, and industrial composition.

*Recommendation: Because of the need for multimedia monitoring analyses and because of the mathematical skills developed in the radiation area at Las Vegas, it is recommended that development of data interpretation techniques become an important component of the monitoring research program at NERC-Las Vegas.*

It should be noted that NPA's 3, 4, 5, and 6 include a substantial quality assurance function. This function performs an essential role for users of instruments and measurement techniques by developing quality control procedures for sampling and analytical methods. Quality assurance would be provided as an ancillary support function within each of these NPA's. Quality assurance in the radiation area is included but is not identified as a separate NPA because of its relatively small size.

## B. Transfer of Functions

There are strong indications that EPA's prospects for additional resources for environmental research—over the immediate future, at least—are very bleak. There is a great possibility, in fact, that there will be virtually no increases in environmental research budgets over the next two or three fiscal years. EPA's budget request for FY-1974 shows no substantial increases in research funds. Increases in specific areas call for corresponding decreases in lower priority areas. The net result is no change. If allowance is made for increased research costs due to inflation, the net effect will be, it appears, a *decrease* in EPA's annual research budget. It also appears unlikely that there will be any significant increase in positions in the EPA research program.

Recent passage of the water bill will create a big demand for monitoring data if timetables for implementation of water pollution standards are similar to those for air pollution standards. The need for consolidating and optimizing research monitoring activities will, therefore, be more pressing. Given a limited resource picture, every effort must be made to secure more output for our investment. Cost/benefit studies establish that fragmented efforts or duplication do not produce desired results. As a result of this dismal resource picture, it becomes increasingly essential that EPA utilize its limited research resources in the most efficient and effective way possible to obtain the greatest research product per research dollar invested. It is therefore necessary to take all possible steps to reduce excess administrative costs, non-essential activities, and any other operations which, while useful in themselves, are not absolutely essential to the research product.

As a general guideline, it would appear particularly constructive to take all steps that can reasonably be taken to strengthen EPA's field research activities, for it is here—in the NERC programs—that EPA's research product is created. Major emphasis should be placed on program improvement, establishment of a critical mass of expertise, and organizational efficiency. In some instances, this may be accomplished by consolidating research activities similar in nature but geographically fragmented. An example of a step already taken is the move of the air ecology program from NERC-RTP to NERC-Corvallis. In this case, one of the overriding considerations was the need to establish a critical base of skills in order to attack the problem on an integrated basis considering all media—air, water, and land. The purpose of such consolidations, therefore, would be to build a solid research base at each NERC which provides all of the necessary skills and expertise to carry out research programs with the greatest possible efficiency.

In the case of Las Vegas, the most serious obstacle to the development of a truly integrated research base is the small size of the existing research activities—that is, no specific critical mass of expertise. At present, the total *research* activity at NERC-Las Vegas, including the AEC research programs, consists of 87 positions and only $1.85 million in research funds. Of these 87 research positions, 16 are engaged in managing the NERC programs and 32 are funded by the AEC and are engaged in research on the effects of radioactive substances on man and animals, leaving *only 39 positions devoted to research activities under direct ORM control.* Of these 39, 23 positions are involved in the National Eutrophication Survey, making it the largest single ORM program at the NERC. Furthermore, NERC-Las Vegas has no associated laboratories. With no current research in air pollution and only a

relatively small effort in water pollution research projects (principally, the National Eutrophication Survey), it is difficult to see how the NERC-Las Vegas can be considered an "integrated" or "balanced" program. The research component is, at present, so small that it does not possess sufficient mass to constitute an effective research effort.

Comparing NERC-Las Vegas with the other three NERC's, one can readily see that unless resources are committed to expand the programs and make them encompass all media, the idea of a NERC at Las Vegas will never get off the ground. For example, NERC-Research Triangle Park, including its associated laboratories, has an ORM commitment of approximately 630 positions and $61 million annually—12 times larger than NERC-Las Vegas in positions and 30 times larger in budget. The other two NERC's are also much larger than NERC-Las Vegas, with 361 ORM positions at NERC-Cincinnati, and 412 ORM positions at NERC-Corvallis.

In view of the need to obtain additional resources for NERC-Las Vegas to assure that an adequate research program begins to evolve there, and in view of the advantages of consolidating certain monitoring research activities in one location, ORM should work toward establishing a critical mass of expertise. To implement this approach, it is necessary to consider transferring some functions to NERC-Las Vegas from other locations.

Monitoring-oriented programs in ORM appear to be very fragmented. Perhaps this is most noticeable where programs of a purely operational nature are being carried out in Headquarters. Based in Washington, these functions, lacking access to laboratory facilities, must try to provide direct day-to-day communication to program chiefs in the NERC's. Given these factors, the operational aspects of the Washington-based programs must be considered as prime candidates for relocation.

The Laboratory Operations Division has attempted to identify those monitoring functions located in Headquarters which are definitely of an *operational* nature and which could best be carried out in a laboratory setting where specialized facilities, equipment, and data are available to meet the research and monitoring objectives.

The Advanced Techniques Division in the Office of Monitoring is responsible for testing and evaluating techniques and analytical methodology for advanced remote and *in situ* sensing of environmental parameters. It also develops and evaluates advanced interpretive techniques to ensure that acquired sensor data are of suitable quality for analyses. In addition, the Division operates monitoring networks, as directed, to support research programs, which is clearly operational in nature.

At present, the Advanced Techniques Division is establishing a helicopter monitoring program using contact and remote sensing equipment. These helicopters will carry out monitoring operations to support the Regions. In another project, the Division is assisting NERC-Las Vegas in the further development of an aerial monitoring program which utilizes the NERC's aircraft. The Division also is engaged in the field testing and evaluation of remote sensing instrumentation for future replacement of existing monitoring equipment. In addition, the Division provides technical assistance to Region II, which is establishing an air monitoring function, and to the Regional Air Pollution Study in St. Louis.

*Recommendation: Since some of the programs of the Advanced Techniques Division are operational in nature, and most of the effort involves the capabilities and expertise of NERC-Las Vegas, it is highly desirable that the operating function and positions associated with this function be transferred from Headquarters to NERC-Las Vegas. At Las Vegas, the Division's staff can be integrated with the existing staff and thereby provide the NERC with additional, critically needed expertise to support its aerial and remote monitoring programs. This transfer will ultimately permit development of a substantial ORM research capability in the remote sensing area.*

Another research area which appears to have an operational function is the development of guidelines for the treatment of environmental quality data on a multimedia basis. Since each monitoring network in the Agency is collecting data in a specific medium or for a specific pollutant, the Data Audit Branch of the Planning and Review Division, Office of Monitoring, develops methods for interpreting environmental quality data using multimedia approaches. These methods are intended to result in data, statistics, and indices which have multiple analytical uses and adequately reflect the total environment.

As a first step in carrying out its responsibilities, the Data Audit Branch, with contractor assistance, is determining who uses environmental quality data both inside and outside EPA, as well as how they use it. With this information, the Branch will begin auditing the quality of existing environmental data and can initiate development of guidelines for the collection and analysis of these data, ensuring that future environmental quality data can be analyzed along multimedia lines.

*Recommendation: Because of its interrelationship with the operational programs and its need for data analytical capabilities, the operational function of the Data Audit Branch should be transferred to NERC-Las Vegas to provide the expertise needed to assist in the research and development activity as it relates to multimedia environmental monitoring techniques and procedures.*

The Quality Assurance Division, Office of Monitoring, directs the development and implementation of a total quality control program for all EPA environmental monitoring activities. Included in the programs are: (a) the development and continuous updating of the Agency's quality control strategy to reflect changing monitoring requirements; (b) the issuance of quality control procedures and guidelines; (c) the establishment and operation of a system for transferring the latest quality control practices to the operating monitoring programs; (d) the evaluation of the quality and availability of standard reference materials and samples; and (e) the supervision of periodic spot checks on the accuracy of calibration and adequacy of quality control practices in field and laboratory monitoring programs. The Division is also responsible for coordinating the Agency's sampling and analytical methodology standardization program, which ensures that reference methodology is available throughout the Agency for assuring the comparability of pollutant data. This role involves the following areas: (a) development of specifications for the design of monitoring instruments systems, (b) establishment of criteria for determining the equivalency of the many available sampling and analytical methods; (c) collaborative testing of proposed reference methods and procedures, and (d) establishment of guidelines for evaluating reference methods and procedures.

*Recommendation: Among the Quality Assurance Division's responsibilities is the coordination of Agency-wide quality control activities. This obviously is a Headquarters function. However, other major functions are operational in nature, among which are issuing technical guidelines, procedures, and manuals, and examining and evaluating field and laboratory practices as well as analytical methodology. Such operational activities of the Quality Assurance Division should be transferred to NERC-Las Vegas. Goal setting and long-range planning functions are the responsibility of the Office of Monitoring at Headquarters and should remain at Headquarters.*

The recommended transfers of functions clearly will not solve the problem of providing the necessary research funding for NERC programs, nor will they provide all of the staffing necessary to establish an initial base of NERC programs for FY 1974. Other sources of funding should be sought.

*Recommendation: As an initial step toward acquiring additional funds, all intramural and extramural funding as well as positions associated with these functions should also be transferred from Headquarters to NERC-Las Vegas.*

If these recommendations are implemented and all positions are transferred by spring 1973, this would greatly assist in beginning the process of evolution of the laboratory toward the NERC concept, but it will do little more. The resources are not sufficient to provide the momentum and diversity that are required. These transfers will not, for example, provide sufficient funds and staffing to achieve full development of some of the NPA's, and they certainly will not solve the more complex problem of obtaining additional resources *beyond* FY 1974.

*Recommendation: These transfers must be regarded as only a "first step" or an "interim" measure to provide partial resources for FY 1974. For this reason, it is recommended that a staff study be undertaken to establish a full set of specific projects and resource needs within each NPA for the period FY 1974 to FY 1979. It is recommended that the Office of Program Coordination, NERC-Las Vegas, take the lead role in developing this study and that the effort be coordinated with Headquarters, ORM, consistent with the ORM planning system.*

Many other functions may exist in Headquarters—besides those within the Office of Monitoring—which are operational in nature. For example, the Implementation Research Division of the Office of Research is initiating a contract to define the status, nature, and extent of air quality monitoring networks throughout the United States. This study examines the location of stations (fixed and mobile), pollutants sampled, frequency of measurement, method of sampling, seasonal and diurnal variations, and inside-outside variations in pollutant concentrations. The goal of the study is to facilitate "a comprehensive appraisal of the adequacy of ambient air quality sampling networks for defining the air quality to which the population are exposed." An examination of this endeavor indicates that it lacks adequate information on laboratory research already done in these areas. This work is operational and belongs at a research center; because the work is of direct significance to monitoring research, it should be transferred from Headquarters to NERC-Las Vegas. Transfer of the function and resources to NERC-Las Vegas would not only give a more well-defined operational focus to the effort, it would also provide the NERC with useful information for

designing monitoring studies (NPA 6 and NPA 7). Other similar projects probably exist in ORM Headquarters which also should be transferred, but an extensive review of these projects is beyond the scope of the report.

*Recommendation: Because of the existence within Headquarters of research components which are operational in nature and which are related to monitoring–besides those within the Office of Monitoring itself–it is recommended that an independent review be carried out of all functions within Headquarters, ORM, to identify those which are operational in nature. As additional functions are identified that are related to the NPA's assigned to NERC-Las Vegas, they should also be transferred to the NERC.*

### C. Organization

The present organizational structure at Las Vegas cannot effectively carry out an expanded research program. To establish a structure that can be effective will require a new organization. In developing this new organization, the following functions should be considered, but they do not necessarily include all functions which could be assigned.

Office of Director

- This office should be responsible for overall operational direction for programs assigned to the NERC. In addition to operational direction and policy, certain staff functions should be established as part of, or reporting to, the Director. These functions are Public Affairs along with Civil Rights and Urban Affairs.

Staff Functions

- Program Coordination. This staff should be responsible for functions such as program planning, program evaluation, technical information, and Regional liaison.
- Special Studies Staff. Although a special staff, this group has a quasi-operational responsibility to carry out special studies on activities such as integrated network design, evaluation of monitoring systems, and predictive modeling.
- Radiation Operations. This function should be established in accordance with a memorandum of agreement between ORP and ORM and should be made responsible for the ORP tenant programs assigned to Las Vegas. The Assistant Director of Radiation Operations should receive his program guidance from the Director, NERC, for the Off-Site Radiological Safety Program. For the ORP Special Studies Program, he should receive guidance from the Office of Radiation Programs.
- Administration. This office should report to the NERC Director and be responsible for providing administrative services to all operating programs. It should include the functions of personnel management, financial management, facilities management, general services, safety, procurement, and personal property management.

Line Functions

- Research and Development. This function should be developed in accordance with the NERC's overall NPA strategy. It should include laboratories and/or divisions developed along program lines in order to enhance the Center's capability of meeting its overall mission.
- Operations. This function should include all other activities of the NERC not defined as R&D. It should contain such functions as quality assurance, aircraft operations, field testing programs, laboratory services, and ADP.

AEC-reimbursable positions should continue to be mixed in the various components of the proposed organization. This is believed to be the most efficient method for meeting the AEC program objectives. However, in the best interest of the Center, the organization should be changed so as to make the best use of available personnel resources.

**D. Administrative Services**

To provide administrative support to the Center as it achieves full status as a NERC will require expansion in the administrative authorities presently delegated to Las Vegas. Present authorities, plus those required in the future, are shown in Table 8. The growth in administrative programs at Las Vegas depends on future growth in ORM programs as well as on growth in the tenant programs.

Given the circumstances that now exist in Las Vegas, where three different organizations provide the personnel resources to staff the administrative operations, it is difficult to plan for growth. To assure that future requirements for administrative support are given appropriate consideration, commensurate with program expansion, several options for maintaining an effective and responsive administrative support activity are possible:

*Option 1: Maintain the status quo.*

This option has no real advantages other than it perpetuates the existing situation. It has the serious disadvantage that no single source of direction or resources is available to the Center Director. Detailed justification for additional staff must be prepared for each organization providing resources and, consequently, each request is considered in terms of that organization's priorities. This does not provide the necessary assurances that adequate resources will be available when needed, and it places the NERC in a situation of not being able to meet the demands for administrative support. Furthermore, this option leads to organizational "layering," which tends to decrease rather than increase overall efficiency.

*Option 2: ORM will provide services and staff, and a Director of Administration will be established.*

This option has the advantage that it provides for a single source of resources and a single point of direction of all administrative support services. In addition, it should assure that an adequate level of support is maintained for all programs. The most significant

Table 8.—Delegations of Authority for NERC-Las Vegas

| | Authorities Delegated | Authorities Not Delegated |
|---|---|---|
| 1. Accounting point | Full | |
| 2. Personnel management | Appointment to GS-15, Classification Actions to GS-15 | |
| 3. Procurement | Open market to $2,500 and unlimited for government source procurement | Contracting, formal bid and negotiated |
| 4. Training | Short term training at 120 days | |
| 5. Incentive awards | To $500 | |
| 6. Travel | Domestic and permanent change of station | |
| 7. Agent cashier | $10,000 cash advanced | |
| 8. Attendance at nongovernment sponsored meetings | Full | |
| 9. Acquisition of duplication equipment & MTST machines | | Non-JCP controlled equipment to $1,000 and renewal of MTST machines |
| 10. Interagency Agreements | To $25,000 | |
| 11. Approval of research grant awards or negotiation of research contracts | To $100,000 | |
| 12. Clearance of papers, speeches, etc. | Scientific and technical materials which do not relate to policy or other sensitive issues | |
| 13. Motor vehicle | Use of government vehicle between home and duty station | |
| 14. Two-color printing | | For informational material |
| 15. Paid advertisement | | For contracting and personnel recruitment |

disadvantage is that ORM must justify the required administrative resources, as well as its research programs. Since ORM's function is primarily research, it isn't prudent or reasonable for precious resources to be diverted into OPM functions and responsibilities.

*Option 3: OPM will provide administrative services through a Director of Administration. The director will receive administrative policy guidance and resources from OPM and day-to-day supervision from the Center Director.*

This option has several major advantages. It would establish a system, like that in NERC-Cincinnati, of administrative support for the NERC under the Deputy Assistant Administrator for Administration; it would relieve the NERC Director of using research positions for administration; and it would effectively reduce ORM's administrative "overhead" burden. The only real disadvantage is that initially all administrative positions would have to be transferred to OPM to provide the staff for the Director of Administration.

*Recommendation: Because of the need to provide the most effective and responsive administrative support possible, commensurate with program expansion at NERC-Las Vegas, it is recommended that Option 3 be adopted: the Office of Planning and Management should provide administrative services for the NERC through a Director of Administration.*

### E. Future Facility Requirements at NERC-Las Vegas

The NERC-Las Vegas headquarters are presently located in a six-building laboratory complex on the campus of the University of Nevada, Las Vegas (UNLV), near the Las Vegas "Strip" and McCarran International Airport. The NERC rents hangar and maintenance space for its 10 specialized aircraft at the McCarran Airport and also operates an experimental farm in the northern part of the AEC's Nevada Test Site, about 120 miles north of Las Vegas.

Five buildings at NERC headquarters are leased from UNLV. Four buildings have leases to 1976, with EPA having an option to extend the leases for another 10 years. The fifth building, Laboratory 2, is leased to June, 1973; no option exists, however, to extend the lease for this building. It is expected that this laboratory will have to be vacated by June, 1973. The sixth building, the Greenhouse, is owned by EPA but is situated on land leased from the University.

The facilities are currently inadequate at NERC-Las Vegas. There is a shortage of storage and general laboratory space. The leasing of additional storage and general laboratory space (initiated in Fall 1972) will temporarily solve this problem.

In dealing with future facility requirements at Las Vegas, two factors must be considered—the location of the NERC headquarters now on the UNLV campus and the location of the aircraft support facility now at McCarran International Airport. Three options exist for the future location of the NERC headquarters:

*Option 1: Expand the present facilities.*

It appears desirable from a research standpoint to be located as near as possible to the University. The UNLV campus is an ideal location for the NERC. The buildings are new and well maintained. The cost of the lease is reasonably low. The drawbacks to this location are that land is limited and expensive. Furthermore, expanding the existing buildings would be expensive. Also, the lease expires on this complex in 1986. At that time, there is a strong possibility that the University will not renegotiate this lease for an additional period of occupancy. However, if EPA could obtain a favorable renegotiation from the University in the near future, with a commitment to expand the present site to meet the NERC's future needs, this option becomes a viable approach.

*Option 2: Vacate present facilities and relocate close to UNLV in a leased facility built to government specifications.*

Relocating NERC headquarters close to the University could be accomplished by having a privately-owned building constructed to EPA specifications. Advantages to this option include the fact that it could be done quickly because EPA has the authority to enter into such a contract. Additionally, this would provide room to expand as well as to build the buildings to EPA specifications. Disadvantages include the fact that this lease would be more expensive, relocation of the present facility would be necessary, the complex would not be directly on campus, and, finally, the land would still be limited because of price. If enough land were available, as well as a lease of at least 20 years with options to extend it longer, this could be a more attractive approach than the first. However, it would require relocation and disruption of the program.

*Option 3: Vacate present facilities and construct the Center facility in the Las Vegas area on a large tract of government-owned land.*

Land is available and could be obtained for a new facility, which could be constructed by the government or by a contractor under a build-lease-purchase agreement. Advantages of this option include lower operating cost for a facility of this type and the fact that it can be modified to enhance the operation of the program. Also, the large tract of land would allow additional field facilities around the complex. Disadvantages include the slowness of this process and the fact that this facility would be off the University.

The most desirable location of the NERC headquarters depends somewhat upon location of the aircraft hangar facilities. The present location at McCarran Airport, the best airport in the Vegas Valley, is ideal. Other possible locations close to the airport include the North Las Vegas Airport and the Boulder City Airport. However, these airports are not as well instrumented as the McCarran airport and, from the standpoint of pilot preference and safety, would not be as adequate unless they were upgraded. The present lease for the EPA hangar facility at McCarran will expire in 3 years. In considering Option 3, it may be desirable to locate the aircraft support activities close to NERC headquarters.

*Recommendation: Because of the need to expand the facilities at NERC-Las Vegas and because of the desirability of remaining close to the University of Nevada-Las Vegas (UNLV), it is recommended that Option 1, expanding the present facilities on the UNLV campus, be adopted. It is recommended that the Agency start now to negotiate build-lease arrangements with the University to obtain a commitment for meeting the future facilities requirements at NERC-Las Vegas.*

The third component of the NERC-Las Vegas facility is the Experimental Farm on the Nevada Test Site. EPA has a permit from AEC to operate this facility, which was built by EPA with AEC money. The farm appears quite adequate for present programs. Because the area is restricted and a large buffer zone exists around the farm, there are minimal problems associated with possible contamination of adjacent land. The disadvantage of the farm is the distance from NERC headquarters—approximately 120 miles or a 2-hour drive. It may be desirable to locate an auxiliary farm site in Las Vegas Valley on land obtained from the U.S. Bureau of Land Management. Such a farm site with water and utilities would provide an auxiliary test facility which could be used in connection with the present farm. There is, however, no strong programmatic justification to place a high priority on a farm in the Las Vegas Valley.

## APPENDIX A

## BUILDINGS AND EQUIPMENT AT NERC-LAS VEGAS

This Appendix describes the facilities of the NERC-Las Vegas, including statistics on the presently occupied buildings and the surrounding area, and outlines the unique capability of the equipment and installations.

### A. Las Vegas Area

Las Vegas, located in the extreme southern part of Nevada, is one of the fastest growing metropolitan areas in the United States. During the 1960-1970 decade, the Las Vegas Standard Metropolitan Statistical Area (SMSA) increased 115 percent to a population of 273,000. It is served by excellent air, highway, and rail transportation. Seven major airlines provide more than 250 flights per day to all major communities in the United States. Direct flights are available to the 10 EPA Regional Offices and Washington, D.C. Interstate Highway 15 connects Las Vegas with Los Angeles and Salt Lake City. Los Angeles is only 45 minutes by air or 290 miles by highway, making communication with research centers at the several major universities in southern California relatively simple. Figure A-1 indicates approximate travel times to locations in the United States.

#### 1. NERC Site

Since July 1966, the NERC central headquarters has been in a $6 million, six-building laboratory complex at 944 East Harmon Avenue on the campus of the University of Nevada-Las Vegas (UNLV). (See Figure A-2.) Located in the Vegas Valley south of the City of Las Vegas, the campus is near the famous Las Vegas "Strip", McCarran International Airport, and the Las Vegas Convention Center. (See Figure A-3.) This complex, built to government specifications, is owned by the University and leased by EPA. The Center also rents hangar and maintenance space for its 10 specialized aircraft at the McCarran International Airport a mile from headquarters. The Center also operates an experimental farm on a 32-acre site in the northern part of the AEC's Nevada Test Site, about 120 miles north of Las Vegas.

#### 2. Adjacent Institutions

While the original reason for locating the facility in Las Vegas was proximity to the Nevada Test Site, other factors contribute to the present desirability of the location. The NERC enjoys a close association with the University, which has approximately 6,000 students and a modern 300-acre campus; four-year and graduate degrees are available in more than 50 major fields. A cooperative relationship has been established between the libraries in the Las Vegas area, which include a large library at UNLV and technical libraries at the AEC, and at EG&G, an AEC contractor.

**FIGURE A-1**
**HIGHWAY MILES AND AIRLINE**
**FLIGHT TIMES FROM LAS VEGAS TO MAJOR**
**CITIES IN THE UNITED STATES**

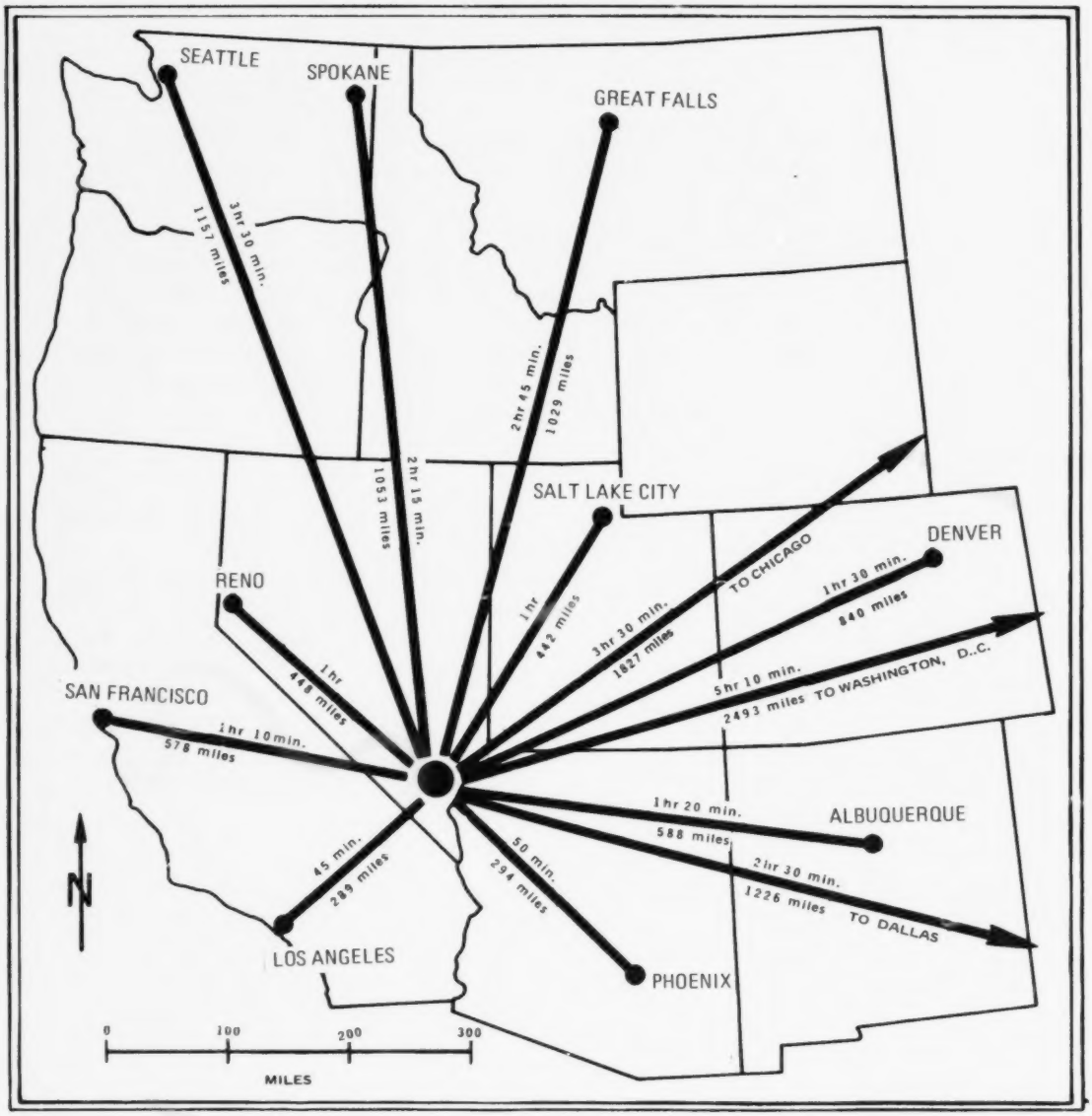
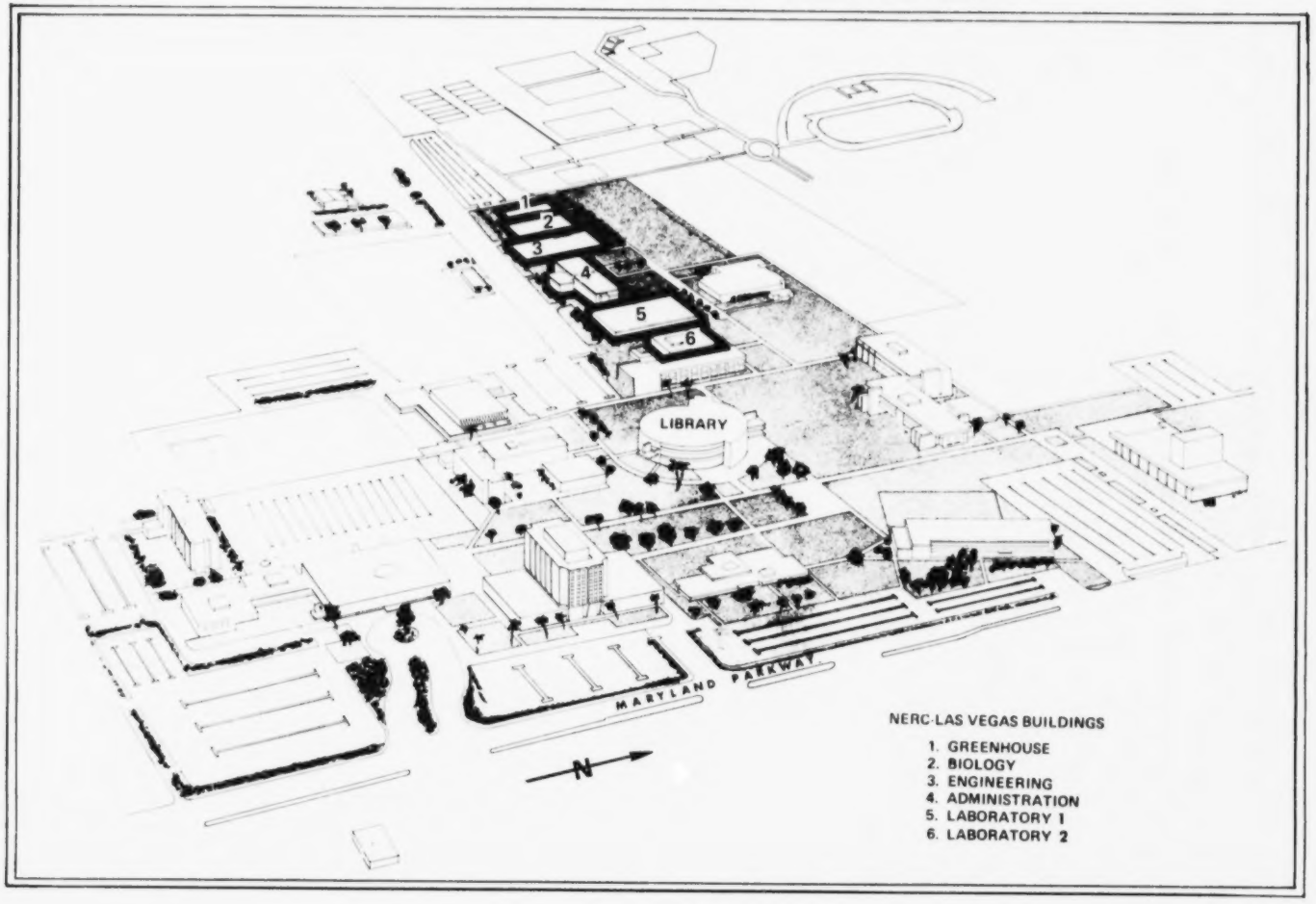
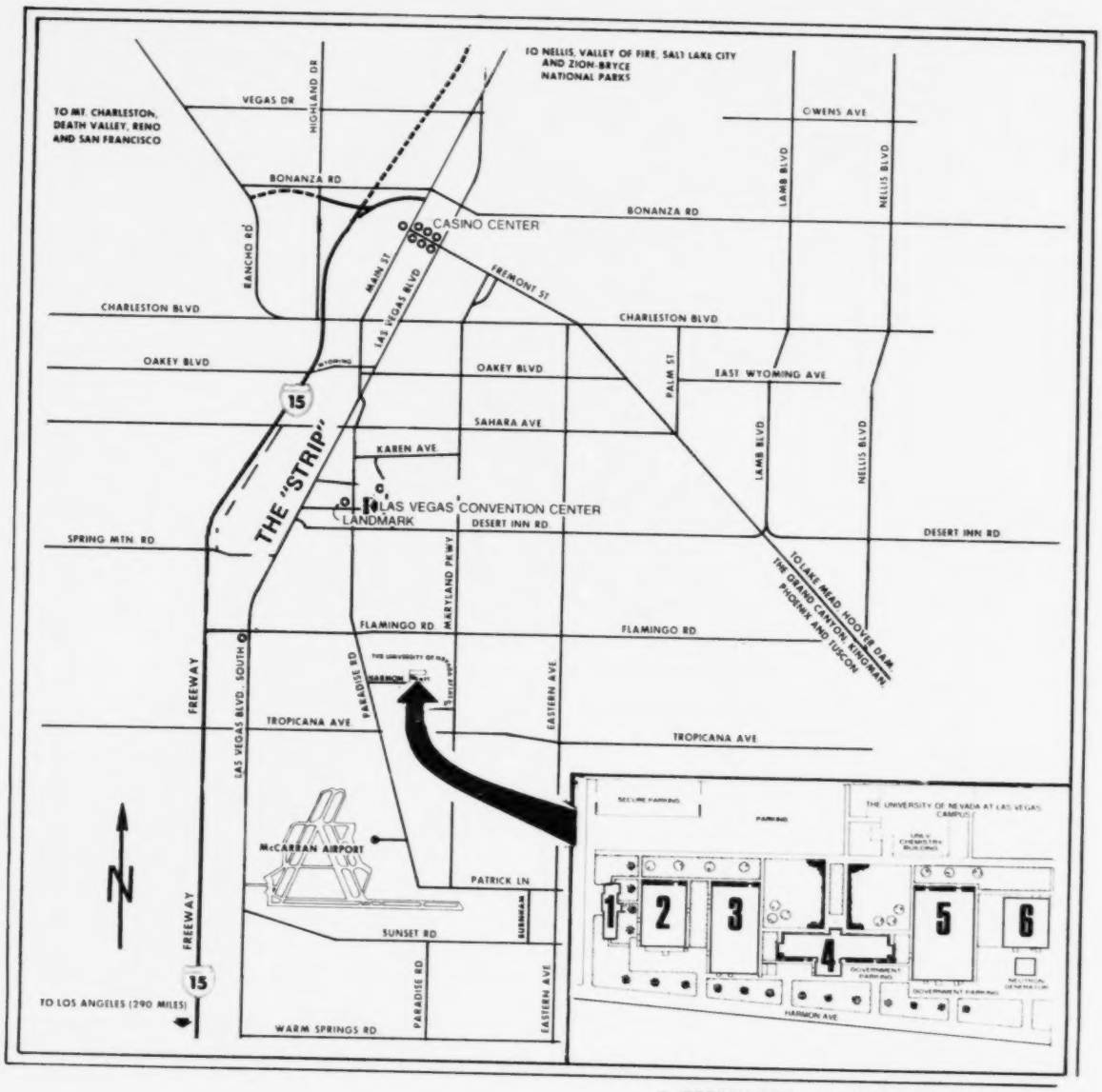


FIGURE A-2
NERC - LAS VEGAS
ON THE CAMPUS OF THE UNIVERSITY OF NEVADA AT LAS VEGAS



## FIGURE A-3

## MAP OF LAS VEGAS SHOWING THE LOCATION OF NERC-LAS VEGAS




1. GREENHOUSE
2. BIOLOGY
3. ENGINEERING
4. ADMINISTRATION
5. LABORATORY 1
6. LABORATORY 2

## B. Buildings

Table A-1, "Space Summary of NERC-Las Vegas Facilities," presents the locations of the various buildings used by the NERC. Additional information is provided on the occupancy basis and the type and amount of usable space in each of these buildings.

## C. Equipment

Table A-2 summarizes the more important and useful equipment and installations which NERC-Las Vegas has procured or developed over the past several years. The following sections describe, in detail, the characteristics and potential total environmental uses of these items. The NERC Experimental Farm on the Nevada Test Site is also described. This facility was designed to accommodate experiments directed toward defining exposure-dose-effects relationships from a variety of simulated environmental sources.

### 1. Aircraft

The NERC has a unique aerial surveillance capability. Its ten specialized aircraft have been used for aerial photography and infrared scanning, airborne pollution detection, aerial

Table A-1.–Space Summary of NERC-Las Vegas Facilities

| Location | Building | Occupancy Basis | Net Usable Space* $ft^2$ | | | |
|---|---|---|---|---|---|---|
| | | | Office | General Laboratory | Special Purpose | Total |
| UNLV Campus | Greenhouse | EPA Owned | 106 | 348 | 2,823 | 3,277 |
| UNLV Campus | Biology | EPA Leased | 1,585 | 2,462 | 5,518 | 9,565 |
| UNLV Campus | Engineering | EPA Leased | 2,899 | – | 13,657 | 16,556 |
| UNLV Campus | Administration | EPA Leased | 7,849 | – | 8,020 | 15,869 |
| UNLV Campus | Laboratory I | EPA Leased | 3,433 | 4,275 | 9,191 | 16,899 |
| UNLV Campus | Laboratory II | GSA Leased | 2,541 | 2,239 | 1,726 | 6,506 |
| Airport | Hangar | EPA Leased | 600 | – | 11,865 | 12,465 |
| Test Site | Farm | AEC Permit | 153 | – | 5,195 | 5,348 |
| Test Site | Well 3 | AEC Permit | 72 | – | 1,848 | 1,920 |
| Total | | | 19,238 | 9,324 | 59,843 | 88,405 |

* Office – Space which is used for employees whose primary duties are working at desks.

General Laboratories – Space which has built-in items such as benches, sinks, hoods, and cabinetry and which is used for such activities as chemistry, physics, and biology.

Special Purpose – a. Space which is used for a unique program activity. Examples include animal facilities, greenhouses, environmental chambers, wind tunnels, etc., or b. Space which is used for activities that support or service the total Center. Examples of such activities include reproduction, mail, storage, conference rooms, auditoriums, cafeterias, model shops, health units, telephones, switchboards, computers, employee lounges, etc.

Table A-2.—Location of Equipment and Installations at NERC-Las Vegas

| Equipment and Installations | Building | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Greenhouse | Biology Building | Engineering Building | Administrative | Laboratory I | Laboratory II | Hangar | Farm | Field Locations |
| Aircraft | | | | | | | X | | X |
| Monitoring Vehicles | X | X | X | | X | X | X | X | X |
| Mobile Laboratories | | X | | | | | | X | |
| Spirometer | X | | | | | | | | |
| Environmental Chambers | X | | | | | | | | |
| Glasshouse | X | | | | | | | | |
| Animal Holding Facilities | | X | | | | | | | |
| Animal Surgical Suite | | X | | | | | | | |
| Shop and Calibration Facilities | | | X | | | | | | |
| Whole Body Counting Facilities | | | | X | | | | | |
| Computer | | | | X | | | | | |
| Radio | | | | X | | | | | |
| Training Facilities | | | | X | X | | | | |
| Neutron Generators | | | | | | X | | | |
| Laboratory Instrumentation | X | X | X | X | X | X | | X | |

sampling and tracking, real-time data analysis and reduction, environmental crisis response, and aircraft maintenance and repair. They are extensively instrumented for tracking and sampling of plumes or clouds of gaseous and particulate contaminants, both radioactive and nonradioactive. By the use of the appropriate detection systems, airborne masses of radioactive materials, condensation nuclei, particulates, or specific gases can be located, measured, and sampled. Sampling equipment in use can collect gross and size-fractionated particulate samples and reactive and inert gas samples. The variety of samplers makes it possible to collect these samples on various media for any desired laboratory analysis.

These aircraft are housed a mile from the NERC at an aircraft hangar at McCarran International Airport. There are approximately 12,465 square feet of aircraft hangar space, including aircraft maintenance shop areas together with approximately 41,419 square feet of paved contiguous ramp, taxiway, and aircraft parking area. The NERC airfleet includes:

One twin-engine Turbo-Beech aircraft, used primarily in cloud-tracking and sampling in support of AEC's nuclear testing programs. This plane is also used for rapid transportation of personnel and equipment and timely pickup and delivery of samples for analysis.

One twin-engine C-45H, used for aerial photography and special missions not related to AEC nuclear testing.

One C-123B, a twin-engine cargo plane with a much larger capacity and range than the C-45H; capable of transporting vehicles, trailers, and portable laboratory equipment to distant locations for rapid survey and assessment of environmental insults. The plane is currently being used for aerial detection and sampling of air pollutants in the Los Angeles smog study.

One OV-1B Mohawk and one OV-1C Mohawk, especially good for aerial photography and multispectral scanning. Used extensively by the U.S. Army in reconnaissance, the planes are particularly well suited to remote sensing of environmental pollutants.

Two U-1A Otters, used for operations involving short airstrip takeoffs and landings or requiring slow air speeds. These planes are primarily used in the National Eutrophication Survey.

Two UH-1H helicopters, used for sampling as part of the National Eutrophication Survey. On-board instrumentation is capable of determining surface temperature, dissolved oxygen, pH, transmissitivity, turbidity, and conductivity.

One TH-55 helicopter, used to provide pilot proficiency training and for developing special monitoring techniques for application in heavier-duty UH-1H helicopters.

2. Monitoring Vehicles

NERC-Las Vegas has 20 2- and 4-wheel drive vehicles which are used around the Nevada Test Site and at other locations where the NERC is involved in research and monitoring activities. These vehicles can spend up to two weeks in the field on sampling missions before stock must be replenished. They are normaliy equipped with such items as portable survey instruments, portable radiation recorders, personnel dosimeters, portable particulate and gaseous air samplers, and containers for environmental samples (e.g., water, soil, milk, feed, and vegetation); some vehicles are equipped for special purposes–such as winch and probe systems for deep well sampling.

3. Mobile Laboratories

The NERC-Las Vegas has six small-to-large mobile laboratories in trucks or trailers which are equipped to support studies conducted at field sites. These laboratories are used for radiation counting, radiochemistry, and water chemistry, and can be readily modified for other monitoring projects where wet chemistry is required.

4. Experimental Farm

The experimental farm in Area 15 of the Nevada Test Site (NTS) was constructed in 1964 to further define the air-forage-cow-milk relationships for the radioiodines.

Presently, studies on the environmental impact of plutonium are being conducted at the experimental farm for the AEC. Specific areas being investigated include: plutonium uptake, tissue distribution, and metabolism in cattle and dairy cows; soil-to-plant-to-animal transfer; and physical characterization of resuspended plutonium aerosols.

Facilities located at the farm are diagrammed in Figures A-4 and A-5 and include:

a. 20 acres of sprinkler-irrigated cropland with deep well pump and reservoir
b. necessary farm machinery for planting and harvesting crops
c. 2960-square-foot laboratory building consisting of:
   (1) 1040-square-foot dairy cow metabolism room with stalls
   (2) 130-square-foot sample control room with perchloric fume hood
   (3) 90-square-foot sample preparation area
   (4) 180-square-foot office and storage room
   (5) 96-square-foot anti-contamination clothing change room with shower
   (6) 240-square-foot utility room
   (7) 216-square-foot milk room
   (8) 968-square-foot milking area with vacuum milking system
d. 960-square-foot storage Quonset
e. 960-square-foot farm machinery shop Quonset
f. 33,600-square-foot corral area with hay storage shed, grain bin, feed bunks, and squeeze chute
g. 80-square-foot greenhouse
h. 210-square-foot oven building with two muffle ovens
i. two 320-square-foot laboratory trailers
j. 30-cow dairy herd
k. 100-animal beef herd which grazes the NTS ranges

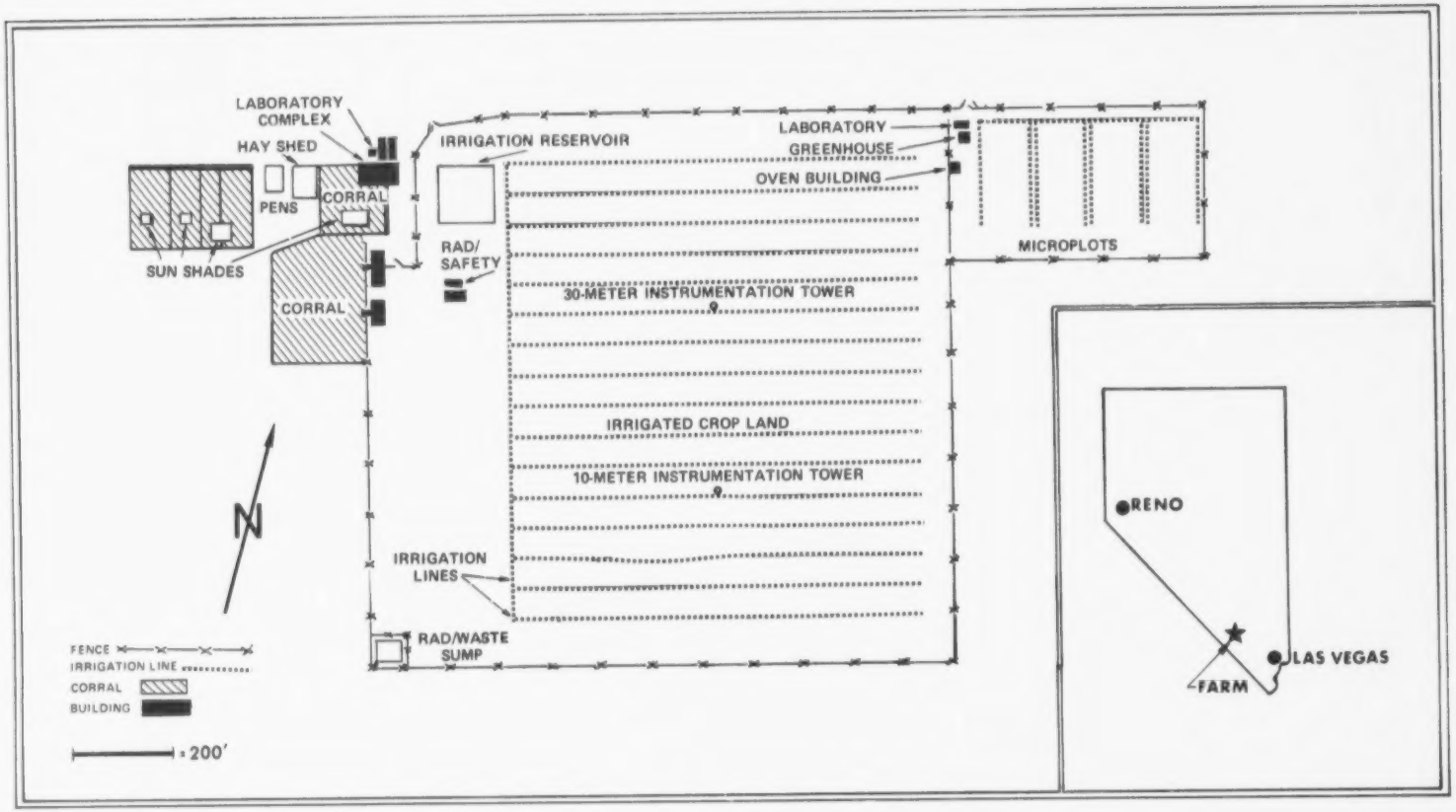
5. Spirometer

A 500-cubic-foot spirometer, one of the largest in the United States, is capable of ±2% calibration accuracy. It is used to calibrate air flow and air volume measuring devices at flow rates up to 200 cubic feet per minute or total volumes up to 500 cubic feet. The control console provides for automatically filling the spirometer tank with air. The spirometer operates throughout its entire range with a pressure differential of less than 1 millimeter of water. Pressure transducers and thermocouples monitor air pressure and temperature in the tank.

The spirometer is routinely used to calibrate air samples, aircraft sampling systems, and secondary standards for field calibration of air samplers. The tank is also used as a mixing chamber to prepare known concentrations of gases in air. These mixtures are used to evaluate collection efficiencies of various types of air samplers.

FIGURE A-4

PLOT PLAN OF THE EPA FARM AT THE NEVADA TEST SITE



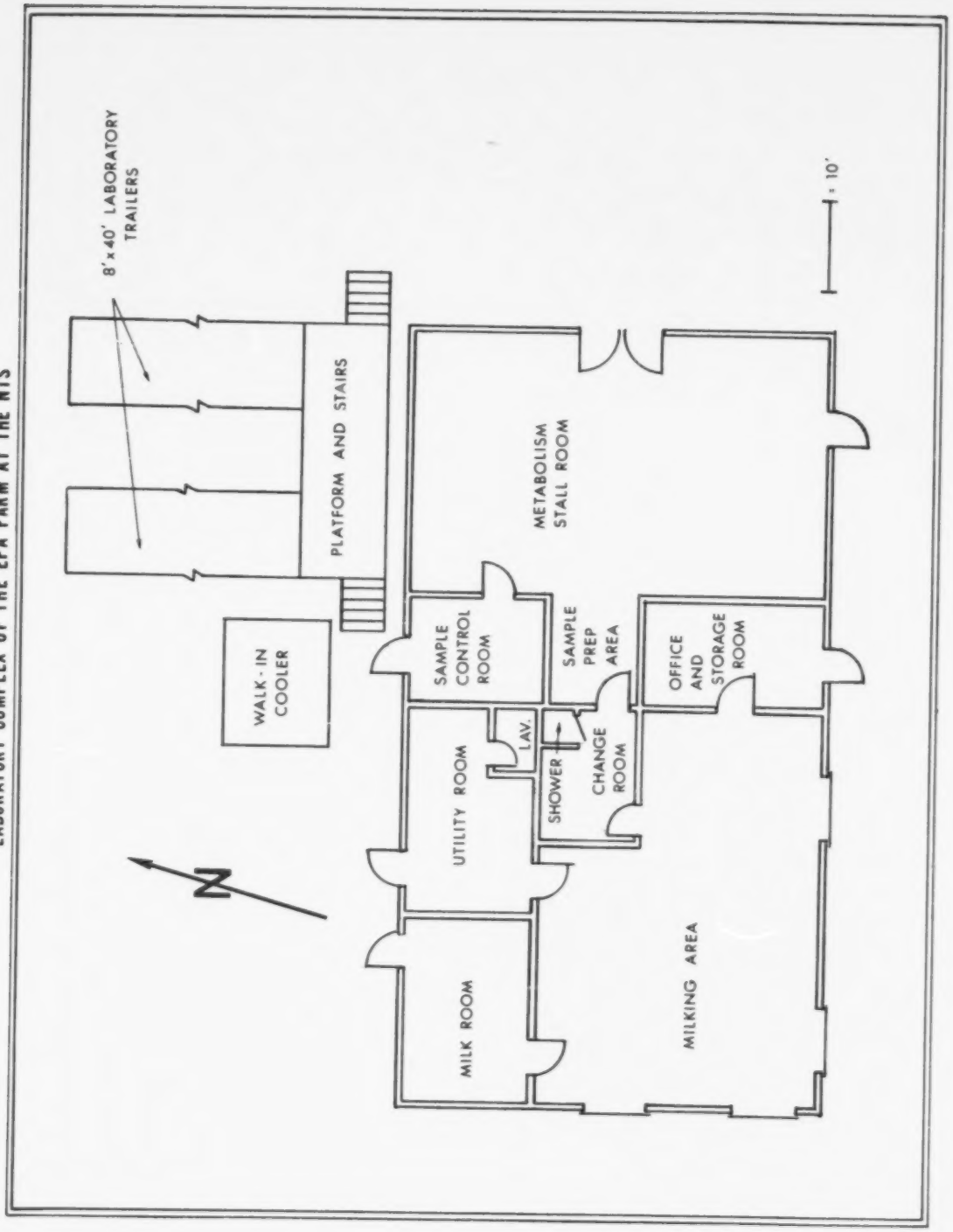



FIGURE A-5
LABORATORY COMPLEX OF THE EPA FARM AT THE NTS

6. Environmental Chambers

There are two large and two small environmental growth chambers in the greenhouse. All are self-contained units with the following capabilities:

Light range – 0 to 5,000 foot-candles

Temperature range – 40 to 95°F

Relative humidity range – 30 to 90%

Air movement – 0 to 2 miles per hour

Carbon dioxide monitor

Photoperiod – day and night light timer

Radiation detection – sequential sampler for measuring air concentration of radionuclides

The larger chambers each have a floor area of 11.5 square feet and a volume of 51.5 cubic feet. The small chambers each have a floor area of 5.6 square feet and a volume of 11.5 cubic feet.

The two large growth chambers were designed to permit handling both radioactive gases and stable air pollutants. It is possible to study such processes as photosynthesis, transpiration, and respiration under varying conditions of temperature, humidity, light intensity, day length, wind speed, and level of pollutant.

There is one environmental chamber in the Engineering Building which is designed for testing instrumentation under various environmental conditions. Temperature, humidity, and pressure can be varied either manually or in automatic cycles.

7. Glasshouse

The glasshouse is used for germination and growth of plants. Capabilities include light banks to provide varying periods of light and air and nutrient solution outlets. The size of the glasshouse prevents large scale agricultural testing, but there is ample room to produce plant material needed for physiological studies. Germination trials are done, as well as some tests on the effects of air pollutants and radiation.

8. Animal Holding Facilities

Medium- and large-sized laboratory animals can be housed in a 560-square-foot, semi-enclosed facility. It is partitioned into roomy stalls to permit the confined animals a limited amount of exercise. The design is flexible enough to provide, with inexpensive modifications, adequate housing for a variety of animals. For example, goats, swine, cattle, dogs, cats, and rabbits have been housed in this facility at various times.

Three rooms with a total floor space of about 2100 square feet are designed to provide adequate housing facilities for small- and medium-sized laboratory animals (mice to swine). Depending on housing requirements (group or individual), the total capacity would range

from about 6500 mice down to 60 miniature swine. These rooms are environmentally controlled for temperature, humidity, and light (periodicity, intensity, and duration).

### 9. Animal Surgical Suite

The surgical suite consists of a 310-square-foot room equipped with diagnostic, surgical, and physiological monitoring equipment for support of biological studies. Equipment includes a diagnostic x-ray unit, a small animal spirometer, a multiparameter physiograph, an animal surgery table with a track-mounted surgical light, and a magnascanner to map deposited radioactive material and inhalation anesthesia apparatus.

### 10. Shop and Calibration Facilities

The NERC and its operating programs are supported by an engineering group which provides professional engineering services in the realms of electronic, mechanical, electrical, civil, and systems development engineering. In addition to equipment maintenance and repair, systems design and fabrication and prototype construction services are provided. A well staffed and equipped craft section provides machining, metal working, welding, and carpentry services for the repair, modification, development, and production of laboratory apparatus. Past examples include the design and fabrication of a data acquisitions system for use in the aircraft and a natural gas burner which was designed and constructed for collection of water vapor for tritium analysis.

### 11. Whole Body Counting Facility

The Whole Body Counting Facility consists of a large room 25 feet below ground containing two heavily shielded chambers—one for a whole body counter and the other for a whole body scanner—and the associated electronic system. In addition to the 160 tons of steel plating which form the two chambers, shielding is provided by a 2-foot layer of concrete and a 4-foot earth layer above the room. The chambers are ventilated with a filtered forced-air system.

The facility is used to determine the location, identity, and quantity of radionuclides which may have entered the body through ingestion or inhalation or which have been deposited internally by other means. Currently, it is being used to monitor families living in the off-site area surrounding the Nevada Test Site to determine their body burdens of radionuclides several years after the Limited Test Ban Treaty went into effect. The facility is a medical tool for diagnosing certain illnesses and diseases and a research tool for determining the behavior in the body of radionuclides or materials tagged with radionuclides.

### 12. Computer

The NERC-Las Vegas Computer System consists of a Control Data Corporation (CDC) 1700 terminal computer which provides communications interface for remote job entry to a central CDC 6400 computer at the AEC's Nevada Operations Office in Las Vegas. At present, the computer is used primarily for scientific and data management applications in support of surveillance activities. The computer facility is also used for a number of administrative applications such as the laboratory's financial management and property accountability records system. Specifications of the computer system are listed in Table A-3.

Table A-3.–Specifications of the NERC-Las Vegas Computer System

| | Central Computer | NERC Terminal |
|---|---|---|
| Storage | | |
| Main core | 65,536 words (60 bits/word) | 16,000 words (18 bits/word) |
| Peripheral core | 4,096 words (18 bits/word) | -- |
| Main disc | 131 million words (6 bits/word) | -- |
| Peripheral disk | 8.2 million words (6 bits/word) | -- |
| Tape drives | 9-track (2), 7-track (5) | 7-track (2) |
| Input/Output | | |
| Card reader | 1200 cards/minute | 500 cards/minute |
| Card punch | -- | 100-476 cards/minute |
| Printer | 1200 lines/minute | 400 lines/minute |
| Paper tape | -- | Reader |
| Plotter | 30-inch calcomp | Calcomp |
| Microfilm | Recorder (30 frames/second) | -- |

## 13. Radio

A standby radio station, call letters WA7AEL, is maintained to provide immediate communications support for environmental emergencies. Radio communications services are provided in time of disaster or other emergency, including the coordination of emergency information and news exchange, relay of messages, arrangement for supplies, authorizations in and out of disaster areas, and operation of a radio net control service. This facility also serves in the DHEW Emergency Communications System.

## 14. Training Facilities

The NERC complex includes a 300-seat auditorium. National and international symposia, conferences, and meetings have been held in this facility. In addition, there are well-equipped classroom, laboratory, and field facilities used for training activities.

## 15. Neutron Generator

The Cockroft-Walton neutron generator has been used for activation analysis of trace quantities of some elements in environmental samples and to evaluate the hazards involved in use of such machines. As a routine service tool, it has been used to produce short-lived radionuclides for analysis of stable pollutants.

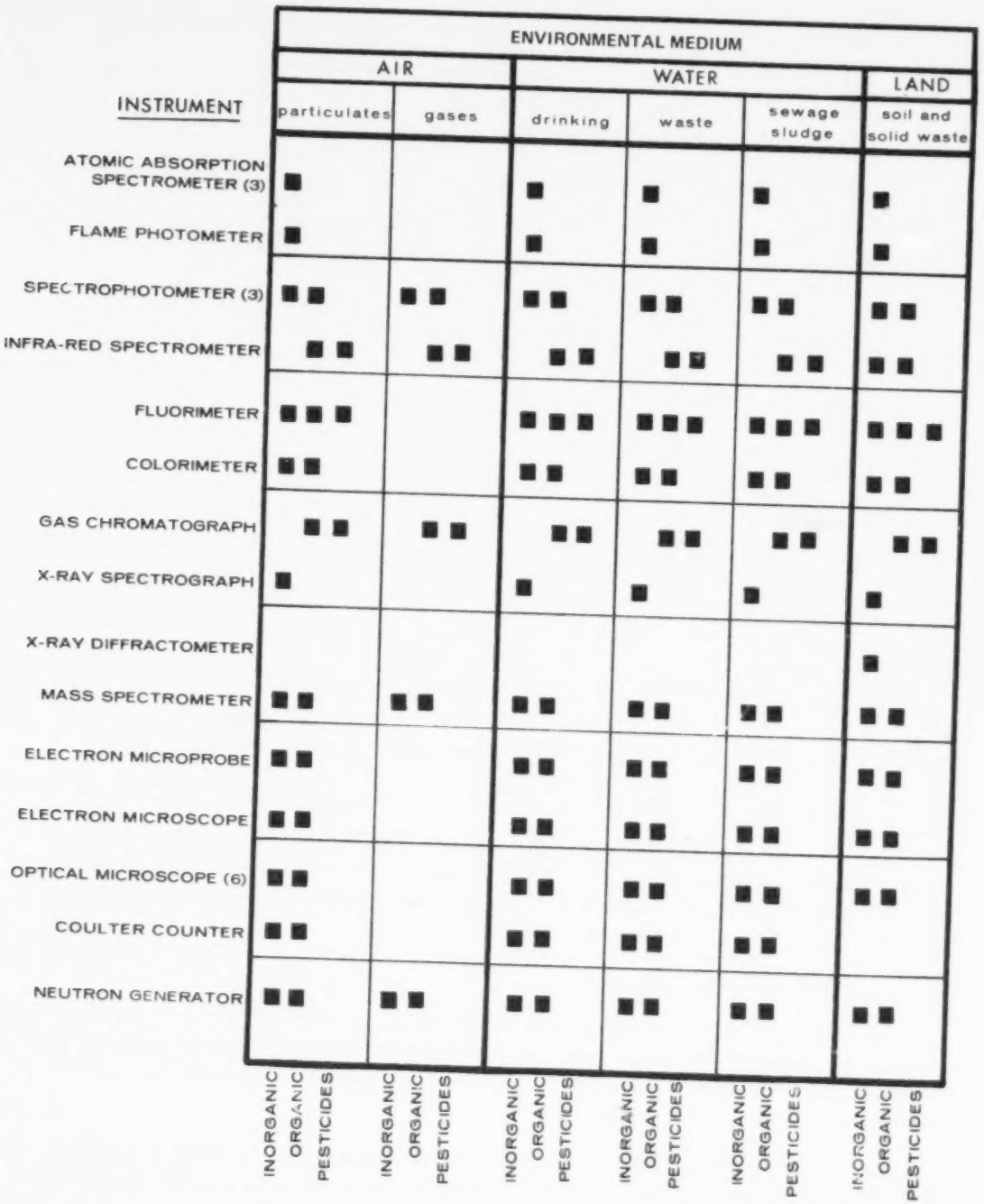
## 16. Laboratory Instrumentation

All the NERC-Las Vegas laboratories are well suited for performing conventional chemical, as well as radiological, analyses. Figure A-6 shows the major equipment items other than radiation detection instrumentation of the lab and a brief summary of the types of pollutants for which the instruments have been or can be used.

The labs have ample bench space, fumehoods, and power. They are all well equipped with minor equipment (such as hot plates, centrifuges, chemicals, glassware, pH meters, and

FIGURE A-6

ENVIRONMENTAL APPLICATION OF SPECIALIZED INSTRUMENTS AT NERC-LAS VEGAS



analytical balances) necessary for radiological analyses. With a minimum of effort, most conventional wet chemical procedures could be performed.

As a former radiological health laboratory, NERC-Las Vegas is well equipped with radiation detection instrumentation for routine analytical use. Included in the inventory of instruments are:

Pulse Height Analyzer Systems–

Gamma – 11 with NaI(T1) crystals

1 with solid state detector

Alpha – 10 solid state detectors

Charged Particle Systems–

Beta – 10 low background

10 proportional (alpha also)

7 liquid scintillation

These systems are used for determining the radioactivity of a variety of environmental samples such as air, water, food, milk, and vegetation.

## APPENDIX B

## DETAILED SUMMARY OF ORM MONITORING-ORIENTED ELEMENTS

This appendix lists, in alpha-numeric order, all the current programs in ORM which include monitoring-oriented portions. There is an entry for each identified Program Element (PE), with the PE number appearing in the left margin, the Responsible Program Implementation Office (RPIO) next, followed by the PE title. The four entries to the right are fund allotments in thousands of dollars (K) and man-years (MY) required for each PE from FY 1973 through FY 1976. Beneath each PE is a description of the specific tasks associated with the PE, followed by the Research Objectives to which these tasks are addressed. These objectives are coded by Research Objectives Achievement Plan (ROAP) numbers. The locations where specific ROAP's are performed are presented along with the program element manager (PEM) and program element director (PED).

The FY 1973 resources presented for each program element and ROAP are based on July 25, 1972, figures. Future resource projections are made only where the data exist. In some cases, projected resources appear to decrease; this may be due to incomplete data, however. In many cases, total ROAP resources may not agree with the program element resources, primarily because management resources have been included in the total program element resources but not in the individual ROAP funding.

| NO. | RPIO | TITLE | FY 73 K | MY | FY 74 K | MY | FY 75 K | MY | FY 76 K | MY |
|---|---|---|---|---|---|---|---|---|---|---|
| 1A1002 | OR&M | Fuel and Fuel Additive Registration | 942 | 8 | 920 | 16 | 1030 | 16 | 855 | 16 |

1. Registration of all fuels and fuel additives. PEM- E. Schuck PED- O. Stopinski (RTP)
   - .Provide standardized test procedures needed for emission characterization
   - .Provide an independently derived information base on the types and amounts of metals, non-metals, and organics present in fuels and fuel additives
   - .Assess the effects of fuel and related exhaust emissions on human health and public welfare, emission control devices, and visibility
   - .Determine fuel emission contributions to total atmospheric pollutant loading
   - .Recommend, as warranted, candidates for regulation

   26AAE-Develop necessary scientific information to analyze fuel and fuel additives, their combustion emission products, and their health and ecological effects. — 881, 6.4 — RTP, North Carolina

| NO. | RPIO | TITLE | FY 73 K | MY | FY 74 K | MY | FY 75 K | MY | FY 76 K | MY |
|---|---|---|---|---|---|---|---|---|---|---|
| 1A1003 | OR&M | Regional Air Pollution Study | 4994 | 13.3 | 10009 | 24.8 | 6630 | 27.7 | 5498 | 26.4 |

1. Analysis of the transport and dispersion processes over a large geographical region associated with stable and reactive air pollutants emanating from a multitude and variety of sources. PEM- H. Wiser PED- P. Allen (RTP)
   - .Obtain an improved understanding of the atmospheric reactions associated with SO2, NOx, hydrocarbons, ozone, organic nitrates, and aldehydes
   - .Define an optimum meteorological measurements network for a Region
   - .Evaluate the representatives of meteorological measurements required for diffusion modeling and control strategies
   - .Test independently developed air quality and environmental models

   26AAI-Development of a pollution prediction model based on an analysis of the transport and dispersion processes of both stable and reactive air pollutants. — 3140, 3.0 — RTP, North Carolina; Washington, DC

   56AAI(3)-Instrument development and field testing, and evaluation of photochemical diffusion models. — 950, 2.0 — RTP, North Carolina

   56AAI(4)-Measurement of CO, SO2, NO, NO2, Hydrocarbons Peroxy acetyl nitrate, Ozone, and particle sizes for sample site determination, pollutant and area-wide source identification, meteorological and photochemical modelling effort — 710, 3.0 — RTP, North Carolina

   56AAI(6)-Reports or recommendations on: — 50.0, 0 — RTP, North Carolina
   1. A prototype environmental effects monitoring package
   2. Pollutant effects on receptors and components of the natural ecosystem.
   3. Correlation of air pollution with measurable ecological impact indicators

   56AAI(7)-Development of a linear programming model capable of yielding a least cost solution from alternative air pollution control approaches by balancing health and ecological — 100.0, 0 — RTP, North Carolina

effects against pollution levels and control costs.

| NO. | RPIO | TITLE | FY 73 K | MY | FY 74 K | MY | FY 75 K | MY | FY 76 K | MY |
|---|---|---|---|---|---|---|---|---|---|---|
| 1A1005 | OR6M | Community Health Effects Surveillance Studies (CHESS) | 6717.0 | 82.0 | 27550 | 432 | 26636 | 415 | 24436 | 398 |

1. Quantification of the health effects of human exposure to air pollutants, and documentation of the health benefits of environmental control.
   - .Develop additional, more sensitive health indicators
   - .Survey human populations to detect health effects resulting from pollutant exposure
   - .Expand the number of pollutants to be studied, including sulfur oxides, nitrogen oxides, particulates, photochemical oxidants, trace metals, and synthetic organic toxic substances such as pesticides

PEM- V. Newill PED- C. Shy (RTP)

21AFS-Comparison of environmental pollution on inner city residents vs. middle class urban dwellers. 0 0

21AFW-Quantification of the impact of community exposure to NO2, SO2, oxidants and particulates. Use of new health indicators and development of national tissue bank. 6320.7 73.0 RTP, North Carolina

| NO. | RPIO | TITLE | FY 73 K | MY | FY 74 K | MY | FY 75 K | MY | FY 76 K | MY |
|---|---|---|---|---|---|---|---|---|---|---|
| 1A1009 | OR6M | Meteorological Research | 3100 | 13 | 6307 | 12 | 5553 | 16 | 5599 | 17.5 |

1. Evaluation of the environmental quality and meteorological-climatological information needed for abatement and control actions.
2. Development of analytical models to estimate the relationship between arbitrary distributions of pollution sources and the resultant air quality
3. Evaluation of the impact of air pollutants on visibility, weather, and climate, at scales ranging from local to global dimensions

PEM- E. Schuck PED- R. McCormick (RTP)

06AJR-Development of measurement methods to define dispersion and physiochemical changes of effluents from large single air pollution sources. Models be developed to characterize pollutant levels away from large sources. 285 1.0 RTP, North Carolina

21ADM-Provision of technical assistance in air pollution meteorology and climatology to EPA, State and local agencies, and assist in episodes. 545 1.0 RTP, North Carolina

21ADO-Development and evaluation of environmental simulation models for describing the temporal and spatial variation in air quality as a function of the emissions distribution and the local meteorolgy. 1555 3.0 RTP, North Carolina

26AAS-Using models predict the airborne concentrations, the factors affecting concentrations, the effect on weather and climate, and the global atmospheric distribution of pollutants from man-made and natural air emissions. 300 2.0 RTP, North Carolinaa

| NO. | RPIO | TITLE | FY 73 K | MY | FY 74 K | MY | FY 75 K | MY | FY 76 K | MY |
|---|---|---|---|---|---|---|---|---|---|---|
| 1A1010 | OR6M | Instrumentation and Analytical Methods Development | 4387.0 | 67 | 6752 | 73.8 | 9699 | 95.2 | 9825 | 101.1 |

1. Development of measurement methods, both manual and instrumental, required to support Federal, State, and local programs for ambient air quality and source emission measurements.
.Develop and recommend methods to the standardization program for ultimate adoption and promulgation as EPA approved methods
.Develop measurement methodology of the air pollution control programs including measurement techniques for all classes of pollutants and pollution sources, mobile and stationary

PEM- A. Forziati PED- P. Altshuller(RTP)

| | | | |
|---|---|---|---|
| 26AAM-Development and field testing of measurement methods and monitoring systems for particulate pollutants emitted from stationary sources. | 939 | 8.8 | RTP, North Carolina |
| 26AAN-Development of measuring methods and monitoring systems for hazardous substances emitted from stationary sources. | 237.3 | 2.5 | RTP, North Carolina |
| 26AAP-Development of measurement methods and monitoring systems for gaseous pollutants emitted from stationary sources. | 955.8 | 8.6 | RTP, North Carolina |
| 26ACV-Development of measurement and instrumentation methods for pollutants emitted from mobile sources, used in vehicle certification processes. | 714.0 | 13.2 | RTP, North Carolina |
| 26ACX-Development of instrumentation for measurement on-site and in the laboratory of gaseous pollutants in ambient air | 726.0 | 9.7 | RTP, North Carolina |
| 26AEK-Development of instrumentation to collect, size, and analyze particulate in the ambient air. measurement and analysis of ambient air particulates | 621 | 9.2 | RTP, North Carolina |

| NO. | RPIO | TITLE | FY 73 K | FY 73 MY | FY 74 K | FY 74 My | FY 75 K | FY 75 MY | FY 76 K | FY 76 MY |
|---|---|---|---|---|---|---|---|---|---|---|
| 1H1327<br>1A1011 | OR6M | Standardization of Instrumentation and Analytical Methods - Air | 1156.0 | 8.0 | 2036.4 | 11 | 3132 | 14.9 | 3155 | 17.3 |

1. Development of standardized manual methods, standardized instrumental methods, and calibration standards for the qualitative and quantitative measurement of air pollutants.
2. Development of a quality control system involving the use of calibration standards for insuring appropriate and effective utilization of these measurement methods by affected parties.

PEM- G. Morgan PED-

| | | | |
|---|---|---|---|
| 26AAF-Evaluation and standardization of analytical methods for measuring air pollutants, as given in National Ambient Air Quality Standards. | 290.5 | 2.8 | RTP, North Carolina |
| 26AAG-Evaluation of stationary source emission measurement methods at field sites and laboratory for precision, accuracy, sample representativeness, method write-up, potential interferences, and suitability for intended purposes | 474.2 | 2.4 | RTP, North Carolina |
| 26ADE-Evaluation and standardization of test methods given in Exhaust Emission Standards and Test Procedures. | 166.8 | 0.6 | RTP, North Carolina |
| 26ADZ-Development of standard reference materials (SRM's) to be used in standardizing analytical methods. | 204.3 | 1.7 | RTP, North Carolina |

| NO. | RPIO | TITLE | FY 73 K | MY | FY 74 K | MY | FY 75 K | MY | FY 76 K | MY |
|---|---|---|---|---|---|---|---|---|---|---|
| 1H1326<br>1A1108 | OR&M | Fuel and Fuel Additive Surveillance | 233.8 | 1.0 | 510 | 6 | 536 | 7 | 562 | 7 |

1. Development of data required for the registration and regulation of fuels and fuel additives.
   .Establish a national surveillance network and standard analytical methodology for the purpose of analyzing fuels and fuel additives for trace and macro components
   .Support combustion research, biomedical research, and fuels emission research - leading to more comprehensive standards and stronger enforcement

PEM- D. Holmes PED-

26ACP-Analysis of fuels and fuel additives and development of methods for such analysis — 233.8 1.0 — RTP, North Carolina

| NO. | RPIO | TITLE | FY 73 K | MY | FY 74 K | MY | FY 75 K | MY | FY 76 K | MY |
|---|---|---|---|---|---|---|---|---|---|---|
| 1B1023 | OR&M | Fate of Pollutants in Fresh Surface Waters | 954.0 | 21.0 | 2545.4 | 44 | 6995.3 | 79 | 8282.5 | 132.5 |

1. Development of the scientific basis for predicting and assessing the fate of pollutants (municipal, industrial, agricultural, etc.) which enter fresh surface waters and the potential exposure of human and aquatic life to these pollutants.
   .Examine the distribution, the pathways, and the rates of movement, accumulation and degradation of pollutants in fresh surface water systems, including the chemical, physical, and biological factors which influence these phenomena
   .Develop mathematical models which interrelate components and processes of aquatic ecosystems
   .Provide data to support the formulation of rational water quality standards

PEM- A. Joseph PED- W. Sanders(Co)

21AIL-Development and field evaluations of mathematical models to quantitatively describe biological and chemical components, and their reactions and interactions, within distinct freshwater habitats. — 288.9 8.0 — Athens

21AIM-Development of predictive models for the fate and ecological impact of specific pollutants on freshwater ecosystems. — 494.0 5.4 — Athens

21AIN-Determination of rates of significant physiochemical processes and biological processes involved in the fate of oil on marine environments especially in arctic environments. — 0 0

| NO. | RPIO | TITLE | FY 73 K | MY | FY 74 K | MY | FY 75 K | MY | FY 76 K | MY |
|---|---|---|---|---|---|---|---|---|---|---|
| 1B1024 | OR&M | Fate of Pollutants in Ground Waters | 575.0 | 13. | 1665.6 | 25 | 2001.9 | 33 | | |

1. Determination and quantification of the fate of pollutants entering and traversing a ground water resource domain.
   .Determine the national scope and nature of ground water pollution problems
   .Establish scientific criteria for waste disposal site selection
   .Determine the effects of surface pollution on ground water quality
   .Develop water quality monitoring and management methods for ground water environments
   .Develop sub-surface waste disposal using deep well injection, waste treatment lagoons, or solid waste landfills

PEM- A. Joseph PED- J. Keeley(Co)

16AEL-Determination of the impact of deep well waste — 38.0 0.1 — Ada

injection on ground waters by conducting research on-site selection, well design, construction, and monitoring.

21AIO-Determination of ground water quality problems in various regions of U.S. — 160 | 0.5 | Ada

21AKQ-Development of predictive models to describe the fate of pollutants in ground water sources. physical, chemical, and biological interactions of ground water sources studied. — 242.0 | 7.4 | Ada

| NO. | EPIO | TITLE | FY 73 K | FY 73 MY | FY 74 K | FY 74 MY | FY 75 K | FY 75 MY | FY 76 K | FY 76 MY |
|---|---|---|---|---|---|---|---|---|---|---|
| 1B1025 | OR&M | Fate of Pollutants in Marine Waters | 1327.0 | 19.5 | 4314.0 | 62.5 | 4396.0 | 61.7 | | |

1. Development of the scientific basis for predicting and assessing the fate of pollutants discharged directly or indirectly into marine waters.
2. Development of techniques for marine environmental quality enhancement.
   .Determine distribution, pathways, and rates of movement, accumulation and degradation of pollutants in oceanic waters
   .Establish scientific criteria for marine disposal site selection and optimum disposal methods
   .Characterize pollutional nature of wastes, sludges and debris discharged in the sea
   .Develop monitoring methods for waste disposal operations

PEM- A. Joseph PED- D. Baumgartner(Co)

01ACG-Determination of methods for utilization of waste resources entering the marine environment. — 3.0 | 0.1 | Corvallis

21AIS-Determination of fate of pollutants in marine environment through laboratory and field monitoring programs. Results will recommend marine water quality criteria, maximum effluent concentrations, and monitoring techniques. — 588.0 | 7.7 | Corvallis

21AIT-Development of predictive models to describe the fate of pollutants in the marine environment. Results used to establish water quality standards, design and implement pollution control procedures, etc. — 265.5 | 0.7 | Corvallis

21AIV-Determination of the chemical behavior, biological interaction, and physical modeling needed to quantify fate of oils discharged into the marine environment. — 9.0 | 0.3 | Corvallis, Cincinnati

21AIW-Evaluation of existing marine methods of field sampling by in situ sensors, remote sensing and standardization of sampling procedures for estuaries and coastal waters. — 3.0 | 0.1 | Corvallis

21AKE-Development of predictive models to quantitatively describe fate of pollutants in estuaries. Results used to establish water quality standards, design and implement pollution control procedures, etc. — 138.0 | 1.6 | Corvallis

| NO. | EPIO | TITLE | FY 73 K | FY 73 MY | FY 74 K | FY 74 MY | FY 75 K | FY 75 MY | FY 76 K | FY 76 MY |
|---|---|---|---|---|---|---|---|---|---|---|
| 1B1026 | OR&M | Fate of Pollutants in Large Lakes | 1163.0 | 6.0 | 2242.0 | 17.5 | 2177.0 | 25.5 | 2075.0 | 22.0 |

1. Development of the scientific basis for predicting and assessing the fate of pollutants in large lakes.
2. Development of methodology and information for lake water quality enhancement.
   .Study the effects of nutrient enrichment and eutrophication, aquatic weed control, bank erosion and sedimentation, dredge spoils disposal, and industrial

PEM- A. Joseph PED- N. Jaworski(Co)

wastes
.Develop and improve mathematical models for lake water quality management

21AKP-Development of predictive models to quantitatively describe fate of pollutants in large lakes. 700.0 1.7 Grosse Ile

21AKR-Determination of the amount and ecological impact of oil discharges to large lakes other than the Great Lakes, emphasizing Arctic lakes. 34.0 0 Grosse Ile

25ADR-Development of guidelines for nutrient control in large lakes, by field and laboratory monitoring studies relating impact of nutrients on water quality, transport mechanisms, factors controlling algal populations. 107.0 1.0 Grosse Ile

25ADS-Determination of the significance of thermal discharges to large lakes by field and laboratory monitoring studies of waste heat. Guidelines developed from this knowledge. 77.0 1.0 Grosse Ile

25ADX-Determination of the magnitude of dredging and disposal of dredging spoils, the problems, and impact on the ecosystem for large lakes. 112. 1.0 Grosse Ile

| NO. | RPIO | TITLE | FY 73 K | MY | FY 74 K | MY | FY 75 K | MY | FY 76 K | MY |
|---|---|---|---|---|---|---|---|---|---|---|
| 1B1027 | OR6M | Methods Development for Identification of Pollutants | 3214.0 | 77.0 | 3560.0 | 69.1 | 3607.0 | 79.4 | 3521.0 | 84.3 |

1. Development of physical, chemical, and biological methods for detection, identification, and measurement of water pollutants.
.Develop sensors and methods that will indicate the presence of pollutants and measure their quantity down to required levels, rapidly and continuously
.Develop the necessary instrumentation to utilize these sensors and methods to identify, measure, and trace pollutants automatically, and economically, both in-situ and by remote sensing
.Develop statistical testing plans to enable rapid screening of water for pollutants with a minimum number of samples
.Develop mathematical models that predict the sources of a pollutant from the information obtained in downstream testing

PEM- A. Forziati PED- D. Ballinger(Ci) W. Donaldson(Co)

05AED-Development of methods for rapid detection of disease-causing bacteria in natural and waste waters, and related environmental materials. Evaluate measurement methods for sensitivity, selectivity, and accuracy. 86.0 2.3 Cincinnati

05AEP-Development of measurement methods for field collection and processing of biological samples, organism identification, biomass and rates of biological processes, biomonitoring and bioassays, bioaccumulation; and biological data processing and interpretation. 208. 7.0 Cincinnati

07AAT-Development of improved methodology (standard sampling procedures, quality control, etc.) for the detection, identification, and enumeration of pollution indicator organisms in waters. 78. 1.7 Cincinnati

07ABL-Identification of organic and inorganic pollutants in industrial wastewaters both before and after state-of-the-art waste treatment. 99.4 2.6 Athens

07ADJ-Identification of taste and odor-causing compounds, their threshold concentrations, and their sources. 67.0 1.9

09ABZ-Development, modification, and evaluation of analytical methods for quantitative measurement of organic and inorganic constituents of water and wastes. 455. 17.5 Cincinnati

09AEC-Development of methods for identifying and measuring pesticides in air and water using gas chromatography and mass spectrometer techiques. 0 0

16ACG-Separation and identification of all pollutants in municipal wastewaters both before and after treatment and chlorination. Quantitatively analyze the important pollutants. 126.1 2.5 Athens

16ADN-Development of systems to identify organic chemicals and elemental pollutants, and needed methods for separation and concentration, and computerized interpretive techniques. 601. 8. Athens

16AJA-Development and testing of new chemical and instrumental methods for laboratory and field for identifying and quantifying oils, seeps, spills, and discharges in surface waters. 50. 2.0 Cincinnati

24AAP-Development of a catalog of elemental fingerprints for residual oils, using neutron activation and spark source mass spectrometry. 109.0 2.0 Athens

07AAP-Development of methods for detecting, recovering, and identifying viruses in water. 450.0 7.0 Cincinnati

21AWN-Application of developed analytical techniques for applicability to selected field problems. 79. 2.0 Athens

| NO. | RPIO | TITLE | FY 73 K | FY 73 MY | FY 74 K | FY 74 MY | FY 75 K | FY 75 MY | FY 76 K | FY 76 MY |
|---|---|---|---|---|---|---|---|---|---|---|
| 1B1029 | OR&M | Lake Survey | 2100.0 | 48.0 | 1251.5 | 48.0 | | | | |

1. Identification of those lakes and other impounded bodies of water which receive effluent discharges from municipal sewage treatment plants.
.collect samples from selected lakes for an evaluation of the response of the receiving water to reductions in phosphorus discharge from treatment plants
21ARK-Development of methods to identify which water bodies would respond to phosphorus control measures. 1836.0 48.0 1251.5 48.0

PEM-B. Payne PED- Dr. Jack Gakstatter (CO)

Las Vegas, Corvallis, Washington, DC

| NO. | RPIO | TITLE | FY 73 K | FY 73 MY | FY 74 K | FY 74 MY | FY 75 K | FY 75 MY | FY 76 K | FY 76 MY |
|---|---|---|---|---|---|---|---|---|---|---|
| 1B1030 | OR&M | Water Quality Implementation Research | 1096.0 | 4.0 | 1485.0 | 2.7 | 1155.0 | 2.7 | 550.0 | |

1. Development of effective planning and optimization techniques for water quality management.
.Develop new or improved methods of data acquisition, transmission, processing and application
.Develop innovative institutional arrangements for water quality management
.Develop techniques for evaluating the air pollution and solid waste effects of water pollution control
.Develop reports, recommendations, demonstrations of practicality, and design criteria

PEM- L. Ruff PED- L. Ruff(HQ)

06AFD-Development and evaluation of systems for water reuse and conservation. 45.0 0.2 Washington, DC

16ACB-Development of methods for improved water quality planning methodology. 145.0 0.2 Washington, DC

16AFN-Evaluation of alternative approaches for controlling agricultural pollution. 80.0 0.2 Washington, DC

21AQJ-Development of techniques for analyzing costs and benefits of alternative water pollution contral 200.0 0 Washington, DC

programs.

21AQT-Analysis of present water quality and effluent standards for applicability, reliability, enforceability and recommendations for modification of the standards. 250.0 0 Washington, DC

21ARA-Comparison of social and economic benefits from water resource development projects with their predicted benefits. 86.5 0 Washington, DC

51AQM-Evaluation of legal and administrative institutions affecting water quality management planning programs in selected basins. 125.0 0.2 Washington, DC

51AQK-Development of economic incentives for water quality control (sulfur tax in air). 120.0 0.2 Washington, DC

| NO. | RPIO | TITLE | FY 73 K | FY 73 MY | FY 74 K | FY 74 MY | FY 75 K | FY 75 MY | FY 76 K | FY 76 MY |
|---|---|---|---|---|---|---|---|---|---|---|
| 1B1031 | OR&M | Eutrophication and Lake Restoration | 2147.0 | 45.0 | 2405.6 | 60.4 | 2629.4 | 66.1 | 1272.4 | 21.4 |

1. Development of eutrophication control and restoration procedures for the lakes and ponds of North America. PEM- A. Joseph PED- T. Maloney (Co)
   - .Develop an understanding of the eutrophication processs with emphasis on the role of plant nutrients in aquatic systems, nutrient cycling among water, sediments and biota, and nutrient effects on plant growth
   - .Develop and demonstrate technology to control and reverse eutrophication processes
   - .Develop methods for monitoring eutrophication conditions and for predicting impact of nutrient sources on the eutrophication of natural waters

21AIY-Evaluation of various lake restoration procedures such as advanced waste treatment, dredging, phosphorus precipitation, nutrient exclusion, aeration, sediment drying and flushing on a large scale. 914.4 10.0 Corvallis; Ely, Minn.

21AIZ-Development of methods to inhibit the growth of algae and higher aquatic plants. 212.3 0.9 Corvallis

21AJA-Development of predictive models which quantitatively describe and define ecological phenomena which relate to the eutrophication of lakes and estuaries. 274.3 0.3 Corvallis

21-AJE-Evaluation of sediment-water nutrient exchange under aerobic and anaerobic conditions. Start of field and laboratory studies on surface water enrichment (eutrophication) from septic tanks. Determination of other nutrient inputs from surface waters in the Northwest region. 81. 0.5 Corvallis

21AJF-Development of methods and conducting field and laboratory bioassays to define responses of aquatic organisms (fresh and estuarine) to concentrations of nutrients. Define the critical nutrient levels and establish system to quantitatively assess the degree of eutrophication in lakes. 233. 2.7 Corvallis

21AJG-Development and evaluation of remote sensing techniques for eutrophication studies. 78.0 0.2 Corvallis

| NO. | RPIO | TITLE | FY 73 K | FY 73 MY | FY 74 K | FY 74 MY | FY 75 K | FY 75 MY | FY 76 K | FY 76 MY |
|---|---|---|---|---|---|---|---|---|---|---|
| 1H1327 (1B1109) | OR&M | Standardization of Methods for Identification of Pollutants - Water | 258.0 | 11.0 | 527.0 | 15.2 | 755.0 | 18.0 | 586.0 | 22.3 |

1. Development of standardized physical, chemical and bio- PEM- G. Morgan PED-

logical methods for detection, identification, and measurement of water pollutants.

2. Development of a quality control system involving the use of calibration standards to insure the reliability of all data provided by or for the Office of Water Programs.

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|---|---|---|---|
| 01AAD-Laboratory and field evaluation of commericially-available or prototype instrumentation for continuous or intermittent measurement of water quality parameters | 61.7 | 2.8 | Cincinnati |
| 09ADO-Development of water monitoring system specifications for remote sensing,telemetry, and centralized data handling instrumentation used in collecting real-time data for municipality effluents and water basins. | 15. | 0.5 | Cincinnati |
| 24ACX-Development and distribution of standard reference samples for quality control of chemical, biological and microbiological monitoring(field and laboratory) measurement methods. | 50. | 1.8 | Cincinnati |
| 24AEL-Validation of methods for chemical, biological, and microbiological analyses by designing and conducting interlaboratory analytical verification programs. | 50.0 | 2.5 | Cincinnati |
| 24ALE-Development of field methods to ensure collection of representative samples, optimal temporary storage conditions, and sample treatment and transport methods to obtain most accurate monitoring data. | 20. | 1.4 | Cincinnati |

| NO. | RPIO | TITLE | FY 73 K | FY 73 MY | FY 74 K | FY 74 MY | FY 75 K | FY 75 MY | FY 76 K | FY 76 MY |
|---|---|---|---|---|---|---|---|---|---|---|
| 1B2034 | OR&M | Combined Sewer Overflows and Storm Water Discharges | 2557.0 | 9.0 | 10415.0 | 14.1 | 21310.0 | 18.0 | 22383.0 | 17.9 |

1. Development of new or improved methods of abating pollution caused by discharge of untreated or inadequately treated waters from sewers which carry either storm water or both storm water and sewage, and urban runoff not collected and carried in sewers to a point-discharge.
.Characterize the quality and pollution impact of these wastewaters
.Develop methods (processes, hardware, and techniques) for their control and treatment
.Demonstrate advanced technology full-scale plant systems

PEM- W. Rosenkranz PED- P. Lederman(Ci)

| | | | |
|---|---|---|---|
| 21AAF-Development of methods such as storage, flow regulation and routing, improved sewer construction methods and material, increased efficiency of existing systems for improved storm and combined sewer flow control. | 575. | 1.0 | Cincinnati |
| 21AAG-Development of computer based mathematical models to simulate urban runoff and combined sewer overflow, impacts on environment, help in setting water quality and effluent standards for assessing the pollution contribution from storm and combined sewer overflow. | 225.0 | 1.0 | Cincinnati |
| 21AAH-Development of new physical, chemical, biological methods and upgrade existing methods for treating combined sewer overflows. Identify methods to handle sludges and treatment chemicals. Collect basic data on combined sewer overflow characteristics by developing monitoring equipment and making measurements. | 927.5 | 1.5 | Cincinnati |
| 21AAI-Development of methods for the treatment of storm | 545.0 | 1.0 | |

water discharges including new processes and monitoring instrumentation.

21AAJ-Development of treatment methods to reduce remove sediments and sediment transported pollutants from urban non-sewered runoff, including new processes and monitoring instrumentation. 162.5 0.5 Cincinnati

| NO. | RPIO | TITLE | FY 73 K | FY 73 MY | FY 74 K | FY 74 MY | FY 75 K | FY 75 MY | FY 76 K | FY 76 MY |
|---|---|---|---|---|---|---|---|---|---|---|
| 1B2040 | OR&M | Mining Sources | 2971.0 | 30.0 | 6646.0 | 27.4 | 7706.0 | 37.3 | 8340.0 | 33.9 |

1. Development of methods and management programs for the prevention, alleviation, and abatement of water pollution caused by mineral extraction and mining activities. PEM- W. Lacy PED- J. Convery (Ci)
   - .Develop criteria for the establishment of water quality standards
   - .Determine by means of demonstration projects, the engineering feasibility and the economic vectors associated with large scale abatement and control measures

21AFY-Development of methods for the treatment of acid mine drainage. 441.5 4.0 Cincinnati

21AFZ-Development of methods for preventing and reducing pollution discharges from surface mines, refuse piles, slurry areas, and other surface properties. 30.0 1.2 Cincinnati

21AGA-Development of methods for the control and prevention of the discharge of waterborne pollutants from active or abandoned mines. 13.0 0.5 Cincinnati

21AGB-Development of new mining methods to prevent pollution. 285.4 0.2 Cincinnati; Washington, DC

21AGC-Assistance to States in demonstration programs and monitoring methods for control of small drainage basin mine water pollution. 1812. 4.0 Cincinnati

21AGD-Description of handling and disposal of well service chemicals and muds, use remote sensing to monitor oil-field brine pollution. 0 0

21AGE-Development of methods for phosphate mining slime control by accelerating aging(flocculants, filtration), dewatering aged slimes, utilize slimes in new products. 25.0 1.0 Athens

21AGF-Identification of environmental pollution problems resulting from milling and mining of metallic ions, conducting national waste characterization survey of discharges to provide solutions to the problems. 70. 2.8 Ada

21AGG-Development of methods for the treatment of wash waters from aggregate producing industries(sand,gravel). 30.0 1.2 Ada

| NO. | RPIO | TITLE | FY 73 K | FY 73 MY | FY 74 K | FY 74 MY | FY 75 K | FY 75 MY | FY 76 K | FY 76 MY |
|---|---|---|---|---|---|---|---|---|---|---|
| 1B2041 | OR&M | Oil and Hazardous Materials Spills | 3839.0 | 20.0 | 4340.0 | 22.4 | 1009.0 | 7.4 | 957.0 | 2.7 |

1. Development of technology for the prevention of oil and hazardous material spills and the detection, control, and restoration of the water environment following accidental spills. PEM- W. Lacy PED- P. Lederman (Ci)
   - .Develop spill prevention and control methods at industrial complexes, storage terminals, and major transportation sources
   - .Develop methods for remote and congested areas, warm and cold climates, and fresh and marine waters

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|---|---|---|---|
| .Demonstrate rapid detection and countermeasure techniques<br>.Develop and demonstrate methods for the ultimate disposal or recycling of oil and hazardous materials removed from spill sites | | | |
| 21ANO-Development of aerial surveillance and interpretation systems for location of oil spill threats; monitor by remote sensing waterways and sewers for oil spills. | 0 | | |
| 21ANP-Use of emergency oil spills to test and demonstrate new technology; provide technical assistance to Regions and Office of Oil and Hazardous Materials. | 0 | 0 | |
| 21ANQ-Identification and quantification of flow conditions and effluent characteristics from offshore oil platforms; development of effluent treatment methods. | | | |
| 21ANR-Organization of a National Conference on the prevention and control of spills of hazardous materials. | 53.0 | 0.3 | Cincinnati |
| 21ANS-Evaluation of methods for physical removal of settled hazardous materials in watercourses. | 282.0 | 0.5 | Cincinnati |
| 21ANT-Evaluation of available equipment for physically removing oil from water surfaces. | 200.0 | 0.4 | Cincinnati |
| 21ANU-Development of acoustical methods for monitoring stability of earthen dikes holding hazardous materials. | 0 | 0 | |
| 21ANV-Development and demonstration of foamed barriers and holding bags for containing and collecting spilled hazardous materials. | 71.0 | 0.1 | Cincinnati |
| 21ANW-Under controlled field conditions and actual spill conditions, evaluate methods to control spills of hazardous materials on land; detect and monitor spills; detoxify, destroy, recycle recovered spilled hazardous materials; control spills in watercourses; accelerate restoration of watercourses contaminated by spills. | 383.0 | 1.4 | Cincinnati |
| 21ANX-Development of physical-chemical portable treatment system for hazardous material spills. | 141.0 | 0.5 | Cincinnati |
| 21ANY-Development of instream treatment of hazardous material spills utilizing mass transfer media. | 0 | 0 | |
| 21ANZ-Development of foamed-in-place systems for plugging leaks in damaged hazardous material containers. | 65.0 | 0.3 | Cincinnati |
| 21AOA-Development of devices and methods for preventing hazardous material spills in operations most spill prone and for preventing these spills from reaching watercourses. | 100.0 | 0.8 | Cincinnati |
| 21AOC-Development of methods for treatment of oil spills on land, to prevent runoff waters and removal of spilled oil. | 0 | 0 | |
| 21AOD-Development of methods for detecting and monitoring oil pipeline leaks. | 197.0 | 0.4 | Cincinnati |
| 21AOE-Development and standardization of analytical methods for the identification and quantification of crude oils, waste oils, and refined products in water, sediments, and biological tissues. | 170.0 | 2.1 | Cincinnati |
| 21AOF-Development and field evaluation of oil/water | 244.0 | 0.6 | Cincinnati |

separation systems.

21AOG-Construction of Oil and Hazardous Materials Simulated Environmental Test Tank (OHMSETT) and data aquisition system for carrying out research and monitoring experiments. 725.0 2.0 Cincinnati

21AOH-Development of methods and monitoring instruments for and define physical parameters affecting containment of oil slicks. 246.0 0.4 Cincinnati

21AOI-Development and demonstration of improved waste oil management techniques, including alternate waste oils and methods for reclaiming waste oil. 212.0 0.1 Cincinnati

21AOJ-Development of methods for the microbe degradation of spilled oil. 0 0

21AOK-Development of methods for restoration of oil contaminated shorelines. 0 0

21APU-Determination of monitoring and/or other methods necessary for assessment of damage (physical-chemical, ecological, and economic) to marine environment due to spilled oil. 295.0 0.6 Cincinnati

| NO. | RPIO | TITLE | FY 73 K | FY 73 MY | FY 74 K | FY 74 MY | FY 75 K | FY 75 MY | FY 76 K | FY 76 MY |
|---|---|---|---|---|---|---|---|---|---|---|
| 1B2043 | ORGM | Treatment Process Development and Optimization | 4237.0 | 99.0 | 13505.0 | 86.9 | 14189.0 | 72.1 | 10785.0 | 60.2 |

1. Development of process information for use in design of municipal and municipal-industrial wastewater treatment plants. PEM- W. Rosenkranz PED- J. Convery (Ci)

.Develop new or improved technology for removal of pollutants

.Develop charts and computer systems to facilitate design simulation and evaluation of individual treatment processes and systems of processes

.Develop process control and instrumentation technology

.Develop new or improved methods for non-pollutional disposal of sludges and concentrated pollutants resulting from treatment processes

.Demonstrate advanced technology full-scale plant systems

21AAL-Development and demonstration of technology for the utilization of granular activated carbon for removal of organics from wastewater. 122.5 3.1 Cincinnati; Pomona Pilot Plant, L.A. Sanitary District

21AAM-Development and demonstration of technology for the utilization of activated powdered carbon for removal of organics from wastewater organics from wastewater. 5.0 0.2 Cincinnati

21AAN-Development and evaluation of low cost absorbents (emphasis on powdered form) for the removal of organics from wastewater. 70.0 0.8 Cincinnati

21AAO-Development of processes using chemical oxidants for the removal of organics from wastewater. 12.5 0.5 Cincinnati

21AAP-Development of membrane processes for the removal of organics and/or inorganics from wastewater. 35.0 0.8 Cincinnati

21AAQ-Development of ion exchange processes for the removal of dissolved inorganics (demineralization) from wastewater, evaluate methods for recovery and/or disposal of regenerant brines. 0 0

21AAS-Development and demonstration of new physical and chemical processes for removal of dissolved inorganics from wastewater. 0 0

21AAT-Development of processes for the removal or control of nitrogenous compounds from new or 289.5 4.4 Cincinnati; Blue Plains, Md

| | | | |
|---|---|---|---|
| existing treatment plants. | | | |
| 21AAU-Development of processes for the removal or control of sulfate in wastewater, by initially studying the basic biochemistry of sulfur cycle. | 0 | 0 | |
| 21AAV-Development of physical or chemical processes for the removal or control of nitrogenous compounds from new or existing treatment plants and be compatable with existing processes for solids and BOD removal. | 142.2 | 1.6 | Cincinnati |
| 21AAW-Development of improved biological or chemical processes for the removal of phosphorus from wastewater. | 132.5 | 3.7 | Cincinnati; Blue Plains,Md |
| 21AAX-Development and demonstration of processes for the removal of phosphorus from wastewater by the addition of minerals to an oxygen aeration system. | 115.0 | 0.6 | Cincinnati |
| 21AAY-Determination of effects of phosphate substitutes on metal distribution through treatment plants and development of improved processes for treatment of such substitutes. Monitor wastewater and treatment process effluents for phosphate substitutes. | 0 | 0 | |
| 21AAZ-Design, development, and demonstration of filtration processes for removal of suspended and colloidal solids from wastewater including oxidation pond effluents and industrial wastes. | 2.5 | 0.1 | Cincinnati |
| 21ABA-Development and demonstration of improved sedimentation processes for the removal of suspended and colloidal solids from wastewater, with emphasis on mixing and high rate settlers. | 27.5 | 1.1 | Cincinnati |
| 21ABB-Development and demonstration of air flotation with chemical coagulation-flocculation for the removal of suspended and colloidal solids from wastewater. | 12.5 | 0.5 | Cincinnati |
| 21ABC-Development and evaluation of new suspended and colloidal solids removal processes such as hydrocyclones and magnetic clarification for wastewater. | 0 | 0 | |
| 21ABE-Development of pure oxygen aeration processes including sizing reactors, clarifiers, and solids handling units for the removal of dissolved biodegradable organics from wastewater. | 157.5 | 3.4 | Cincinnati; Washington, DC |
| 21ABF-Evaluation of rotating biological contactor processes for removal of dissolved biodegradable organics from wastewater. | 7.5 | 0.3 | Cincinnati |
| 21ABG-Development of improved air activated sludge processes for removal of dissolved biodegradable organics from wastewater. | 47.5 | 1.9 | Cincinnati |
| 21ABH-Development of improved trickling filter processes for removal of dissolved biodegradable organics from wastewater. | 67.5 | 0.3 | Cincinnati |
| 21ABI-Development of improved oxidation and stabilization ponds for removal of dissolved biodegradable organics from wastewater(control algae and other suspended solids in pond and lagoon effluents). | 107.5 | 0.3 | Cincinnati |
| 21ABK-Determination of the capability of biological and physical-chemical processes to remove organic compounds from wastewater. | 195.0 | 7.3 | Cincinnati |
| 21ABL-Development and demonstration of physical methods for disinfection and removal of microorganisms | 2.5 | 0.1 | Cincinnati |

from wastewaters.

| | | | |
|---|---|---|---|
| 21ABM-Development of chemical methods for disinfection and removal of microorganisms from wastewater. | 180.0 | 2.4 | Cincinnati |
| 21ABO-Determination of heavy metals concentrations in feed to and product from new wastewater treatment methods and develop processes to remove metals not removed by treatment process. | 17.5 | 0.7 | Cincinnati |
| 21ABP-Determination of the ability of microorganisms in disinfected wastewater to reproduce when subjected to varying degrees of dilution by receiving waters even though the microorganisms fail to reproduce in good nutrient media. | 0 | 0 | |
| 21ACG-Development and demonstration of processes for the handling and disposal of sludge from municipal waste treatment plants. | 236.0 | 3.2 | Cincinnati |
| 21ACH-Development of processes and conditioning agents for thickening and dewatering chemical and organic sludge from primary, secondary, and tertiary waste treatment plants. | 382.5 | 5.1 | Blue Plains, MD |
| 21ACI-Development and demonstration of processes for stabilization of sludge from municipal wastewater treatment plant sludge. | 97.5 | 0.9 | Cincinnati |
| 21ACJ-Development of technology for disposal of liquid sludge on land, including environmental impact. | 45.0 | 1.8 | Cincinnati |
| 21ACK-Development of processes for treatment of supernatants from sludge conditioning. | 15.0 | 0.6 | Cincinnati |
| 21ACL-Evaluation of the feasibility of extracting a nutritionally significant organic feed concentrate (animal feed) from heat treatment process of sewage sludge. | 12.5 | 0.5 | Cincinnati |
| 21ACM-Application of conventional and newly developed processes for disposal of brines generated by advanced waste treatment processes. | 0 | 0 | |
| 21ACN-Development and demonstration of processes for handling and disposal of water treatment plant sludges. | 0 | 0 | |
| 21ACP-Development and demonstration of processes for renovation of wastewater for potable reuse. | 170.0 | 6.7 | Cincinnati |
| 21ACQ-Development of processes for renovation of wastewater for non-potable reuse (agricultural, recreational, industrial). | 102.5 | 0.5 | Cincinnati |
| 21ACR-Determination of socio-political impact of wastewater reuse for potable water supply. | 0 | 0 | |
| 21ACT-Development and provision of data on the optimization of wastewater treatment processes, treatment trains, and sewage for municipal treatment plant designers and operators. | 92.5 | 3.7 | Cincinnati |
| 21ACU-Identification of key variables for monitoring and controlling of sewage systems and treatment plants. Evaluate instruments, control devices and control strategies by laboratory and field studies. | 489.0 | 5.8 | Cincinnati; Blue Plains, Md |

| NO. | RPIO | TITLE | FY 73 K | FY 73 MY | FY 74 K | FY 74 MY | FY 75 K | FY 75 MY | FY 76 K | FY 76 MY |
|---|---|---|---|---|---|---|---|---|---|---|
| 1B2044 | OR6M | Cold Climate Waste Treatment | 421.0 | 16.0 | 944.0 | 26.7 | 1930.0 | 23.4 | 1635.0 | 17.4 |

PEM- W. Rosenkranz PED- M. Mitchell(Co)

1. Development of cold climate waste treatment systems. .Develop processes and systems which will provide any level of treatment, up to and including,

complete treatment
Establish criteria for treatment processes development by investigating the tolerances of Arctic aquatic species to various concentrations and forms of man-induced pollution.

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|---|---|---|---|
| 21ABR-Provision of drinking water, bathing and laundry facilities, and waste treatment to certain native alaskan villages. | 194.1 | 4.8 | College, Alaska |
| 21ABS-Application of conventional wastewater treatment processes to Arctic regions and development of new economical waste treatment processes for these regions. | 106.4 | 0.2 | College, Alaska |
| 21ABT-Understanding of the present Arctic aquatic ecosystem and evaluation of the man-included disturbances of it by on-site field investigations. | 0 | 0 | |
| 21ABU-Identification of life cycle requirements of key indigenous vertebrate and invertebrate aquatic species in the Arctic and Sub-Arctic stream which may be disturbed by various land management practices. | 0 | 0 | |
| 21ABV-Development of methods for the treatment of industrial wastes (seafood processing, pulp and paper, and petrochemical) in the Arctic. | 0 | 0 | |

| NO. | RPIO | TITLE | FY 73 K | FY 73 MY | FY 74 K | FY 74 MY | FY 75 K | FY 75 MY | FY 76 K | FY 76 MY |
|---|---|---|---|---|---|---|---|---|---|---|
| 1C1046 | ORGM | Water Quality Health Effects Research | 1531.0 | 58.0 | | | | | | |

1. Development of valid criteria for setting water quality standards for municipal (drinking) and recreational (freshwater and marine) uses:
.Study biological effects resulting from the presence of potentially toxic contaminants in the water environment.

PEM- H. Gorchev PED- G. Robeck(Ci)

| | | | |
|---|---|---|---|
| 21APV-Establishment of health criteria for unknown organic contaminants of drinking water by identifying the toxic substances and performing epidemiological studies of exposed populations. | 93.0 | 2.0 | Cincinnati; Dauphin Isle, Ala.; Narragansett, RI |
| 21APW-Development of methods for the screening of known chemicals for specific toxic effects on drinking water by establishing effect parameters which correlate with more easily measured biochemical indicators of effects. | 310.6 | 8.9 | Cincinnati, Narragansett |
| 21APX-Determination and investigation of waterborne disease by monitoring water supplies for occurences of pathogens, virus, bacteria, higher parasitic forms and by determining conditions in water supplies that allow disease transmission. | 430.0 | 15.4 | Cincinnati; Dauphin Isle; Narragansett; Purdy, Wash. |
| 21APY-Chemically and toxicologically testing of water treatment chemicals, develop methods for the evaluation, review compiled data for safety/ hazard to population, define maximum safe use levels. | 60.0 | 2.1 | Cincinnati, Narragansett |
| 21APZ-Development of health effects criteria for recreational waters by conducting epidemiologic and microbiological monitoring studies to relate health effects to some pollution measure (bacterial and chemical indicators of fecal contamination, pathogens which multiply in eutrophic waters). Monitoring methods developed and adapted | 260.2 | 11.4 | Cincinnati; Narragansett; Gig Harbor, Wash |

to identify and quantify significant health effects indicators.

| NO. | RPIO | TITLE | FY 73 K | FY 73 MY | FY 74 K | FY 74 MY | FY 75 K | FY 75 MY | FY 76 K | FY 76 MY |
|---|---|---|---|---|---|---|---|---|---|---|
| 1C2047 | ORD-M | Water Supply Research | 704.0 | 30.0 | 694.0 | 28.8 | 532.0 | 23.2 | 274.0 | 11.2 |

PEM- B. Gorchev PED- G. Robeck(Ci)

1. Development of methods and management practices for the prevention, abatement, and control of pollution in water supplies.
.Develop technical and administrative water management practices and techniques so as to maintain and protect the sanitary quality of water impoundments destined to be used as drinking water supply sources
.Develop treatment processes for the removal of organic and inorganic contaminants from drinking water
.Develop assay methods for the determination of the toxicity of contaminants found in drinking water
.Design, develop and evaluate innovations in water treatment processes that will be effective in converting treated waste to water suitable for human consumption
.Maintain data file systems on toxicity data and on the epidemiology of water-borne diseases, and the health effects evaluation of long-term, low-level concentrations of contaminants in drinking water

| | | | |
|---|---|---|---|
| 21AQB-Evaluation by field studies and improvement of treatment processes for the removal of trace organics, tastes, and odors from water supplies, using activated carbon. Laboratory studies on alternate adsorbants and oxidants(ozone). | 93.0 | 2.0 | Cincinnati |
| 21AQC-Evaluation and improvement of treatment processes for the removal of turbidity and specific particles from water supplies (coagulants, filter aids, and different granular media). Water treatment plant sludge will be tested for disposal methods. | 16.0 | 0.4 | Cincinnati |
| 21AQD-Evaluation and improvement of treatment processes for the removal of trace metals and nitrates from water supplies. | 82.0 | 3.8 | Cincinnati |
| 21AQE-Evaluation and improvement of methods for elimination of microorganisms in drinking water by studying naturally occuring pathogens (viral and bacterial) influenced by environmental conditions (turbidity, disinfection). | 86.0 | 3.8 | Cincinnati, Narragansett |
| 21AQF-Evaluation and prevention of chemical quality deterioration during distribution of drinking water by monitoring for pollutants at selected consumer taps, and using NSF water quality monitor to relate water type, system materials, and treatment practices to quality deterioration during distribution. | 98.0 | 4.4 | Cincinnati; Narragansett; Dauphin Isl., Ala. |
| 21AQG-Study of the behavior and control of contaminants and additives in drinking water sources during storage by mainly field monitoring studies. | 65.0 | 2.7 | Cincinnati, Dauphin Isl. |
| 21AQH-Evaluation and control of bacterial quality (pipe and bottled) by field monitoring for bacteriological populations, suppression of coliform detection control methods, and establish continuous rapid monitoring techniques for bacterial quality. | 115.5 | 5.0 | Cincinnati; Gig Hargor, Wash |

| | FY 73 | FY 74 | FY 75 | FY 76 |
|---|---|---|---|---|

| NO. | RPIO | TITLE | FY 73 K | FY 73 MY | FY 74 K | FY 74 MY | FY 75 K | FY 75 MY | FY 76 K | FY 76 MY |
|---|---|---|---|---|---|---|---|---|---|---|
| 1E1079 | OR&M | Pesticides Identification Methodology | 204.0 | 12.0 | 216.8 | 13.0 | 260.2 | 14.0 | 260.2 | 14. |

1. Development of multi-residue methods for determining the extent of human and animal exposure to persistent and biodegradable pesticides.
   - .Develop information on the action mechanisms of pesticides and their metabolic products
   - .Develop methodology for the isolation, detection, identification, confirmation and quantification of pesticide residues, metabolites, and other chemical contaminants
   - .Support administrative decisions concerning the registration of pesticides

   PEM- A. Forziati PED- W. Durham(RTP)

   26AEU-Application of existing laboratory methods for and quantification of pesticides, chemical residues, their metabolites, degradation products found in environmental substrates, especially human and animal tissues. 180.7 9.0 Perrine

| NO. | RPIO | TITLE | FY 73 K | FY 73 MY | FY 74 K | FY 74 MY | FY 75 K | FY 75 MY | FY 76 K | FY 76 MY |
|---|---|---|---|---|---|---|---|---|---|---|
| 1H1327 (1E1110) | OR&M | Pesticide Exposure Surveillance | 257.0 | 12.0 | 404.9 | 16.6 | 483.0 | 19.6 | 531.3 | 19.6 |

1. Determination of the levels of selected pesticides in human tissues and in environmental media such as food, water, air and soil.
2. Evaluation of the long-term effects of pesticides on human health through the continuing surveillance of approximately 1,500 volunteer study subjects who are known to have frequent contact with specific pesticides.
3. Determination of the pesticide use patterns within the defined study area of each of the community study projects so as to study the association of certain disease conditions with the use of pesticides.
4. Support studies as may be necessary to provide specific information on individual chemicals or attendant problems.
5. Standardization of analytical methods and measurement techniques for the determination of pesticide concentrations and degrees of exposure.

   PEM- G. Morgan PED-

   26ADT-Provision for analytical quality control service for pesticides to all Regional and other EPA-supported laboratories. 167.6 6.5 Perrine

   26AEW-Evaluation of new instrumentation and methods for pesticide monitoring. 50.0 1.5 Perrine

| NO. | RPIO | TITLE | FY 73 K | FY 73 MY | FY 74 K | FY 74 MY | FY 75 K | FY 75 MY | FY 76 K | FY 76 MY |
|---|---|---|---|---|---|---|---|---|---|---|
| 1F1083 | OR&M | Radiation Pathways Research | 292.0 | 11.5 | 397.0 | 13.0 | | | | |

1. Development of information on the behavior, movement, and fate of radionuclides in the aquatic, terrestrial, and air environments.
   - .Assess radiation dose to man resulting through these multiple pathways
   - .Support setting of radiation protection guides and standards, particularly for nuclear power facilities

   PEM- H. Wiser PED- J. Garner(RTP) A. Moghissi(LV)

   21AMI-Determination of transport processes of selected radionuclides released to the environment by nuclear reactions. 242.0 11.0 Las Vegas

| | FY 73 | FY 74 | FY 75 | FY 76 |
|---|---|---|---|---|

| NO. | RPIO | TITLE | K | MY | K | MY | K | MY | K | MY |
|---|---|---|---|---|---|---|---|---|---|---|
| 1F1084 | OR&M | Radiation Methods and and Measurements | 245.4 | 9.2 | 393.0 | 11.9 | | | | |

1. Development of new or improved methods, instrumentation and theoretical models required to determine the concentrations of radioactive materials and the intensity of electromagnetic radiation in various media, with emphasis on biological materials.
   .Develop laboratory exposure calibration facilities
   .Develop field measurements systems

PEM- A. Forziati PED- J. Garner(RTP)

21ALW-Development of laboratory exposure and measurement systems. 195.4 9.0 RTP-North Carolina

| NO. | RPIO | TITLE | FY 73 K | MY | FY 74 K | MY | FY 75 K | MY | FY 76 K | MY |
|---|---|---|---|---|---|---|---|---|---|---|
| 1H1327 (1F1111) | OR&M | Radiochemical Measurements | 406.0 | 24.0 | 360.0 | 16.3 | 390.0 | 17.2 | 430.0 | 18.0 |

1. Assessment of the character and concentration of radioactive substances discharged from nuclear facilities, especially nuclear power plants.
   .Evaluate types and concentrations of radiochemical discharges and estimate the relative concentrations of radionuclides in the various carrier media in the environs of nuclear facilities.
   .Standardize instruments and analytical methods necessary for the detection and measurements of radio-chemical exposure
   .Report recommendations for conducting effective environmental surveillance

PEM- G. Morgan PED-

17AAE-Development of methods for radionuclide detection and identification around nuclear power and allied industries. Establishment of monitoring networks for water, food, milk, air, around these facilities. 100.0 6.2 Montgomery, Ala

24AAK-Development and field evaluation of methods for radionuclide determination of liquid and airborne effluents from nuclear power stations and allied facilities. 103.7 4.9 Cincinnati

| NO. | RPIO | TITLE | FY 73 K | MY | FY 74 K | MY | FY 75 K | MY | FY 76 K | MY |
|---|---|---|---|---|---|---|---|---|---|---|
| 1H1095 | OR&M | Ecological Impact | 620.5 | 10.7 | | | | | | |

1. Evaluation of the broader questions of environmental impact without regard to medium or category.
   .Carry out research that will help EPA to make comments on environmental impact statements prepared by other Federal agencies
   .Investigate aspects of environmental quality not adequately considered in present environmental impact analyses
   .Develop measures of these and other aspects of environmental quality so as to determine change over time
   .Investigate underlying causes of environmental problems

PEM- E. Royce PED- E. Royce(HQ)

21AQZ-Implementation and evaluation of survey of urban resident attitudes toward environmental quality. 90.0 2.0 Washington, DC

21AQW-Development of methods leading to rational environmental planning process for human settlement. 184.0 2.0 Washington, DC

21AQX-Development of models to describe environmental impact from gas-fired power plants and 190.0 2.0 Washington, DC

from long-term radioactive waste disposal. Multi-media transport models and evaluations of human health and biota will be made.

21AQY-Identification and measurement (monitoring) of elements of environmental quality. 70.0 2.0 Washington, DC

| NO. | RPIO | TITLE | FY 73 K | MY | FY 74 K | MY | FY 75 K | MY | FY 76 K | MY |
|---|---|---|---|---|---|---|---|---|---|---|
| 1H1096 | ORD&M | Ecosystem Research | 860.2 | 2.4 | | | | | | |

PEM- P. House PED- P. House (HQ)

1. Development of an improved understanding of the relationship between environmental problems and the totality of society, including its environmental, social, economic, and institutional systems.
2. Development of the means by which environmental policy and technology can be designed to conform with and effectively utilize these systems.
   - .Identify basic forms of growth and change in urban and regional systems
   - .Develop and evaluate comprehensive models for the assessment of the impact of environmental policy decisions
   - .Identify institutional forms which might be channeled to achieve environmental quality goals

21ALV-Development of predictive and decision-making models dealing with the interaction between pollution and land use, transportation patterns, migration, public finance, demography to determine the most cost/effective approaches to environmental management. 860.2 2.4 Washington, DC

| NO. | RPIO | TITLE | FY 73 K | MY | FY 74 K | MY | FY 75 K | MY | FY 76 K | MY |
|---|---|---|---|---|---|---|---|---|---|---|
| 1H1326 | ORD&M | Advanced Monitoring Techniques | 0 | 0 | | | | | | |

PEM- D. Holmes PED-

1. Development of advanced techniques in support of monitoring operations.
   - .Develop and operate research monitoring networks
   - .Test and evaluate new monitoring sensors (remote and in-situ)
   - .Provide laboratory support for sample analysis
   - .Establish operational aerial environmental monitoring capability

22AAI-Development and operation of research monitoring networks to test and evaluate sensors and monitoring systems. 0 0

22AAJ-Provision of aerial monitoring and surveillance for episodes for Regional Offices and the NERC's 0 0

22AAK-Testing and evaluation of sensors for identifying, monitoring, and quantifying pollutants. 0 0

22AAL-Testing and evaluation of monitoring techniques and instrumentation for more effectively providing environmental data to the Regional Offices and the NERC's . 0 0

22AAM-Procurement of monitoring support from other government agencies where the expertise has already been developed. 0* 0

22AAN-Transfer of funds to other agencies for the testing and evaluation of new technology which could be used in monitoring. 0* 0

22AAO-Development and maintenance of statistical and data handling support for analyzing collected air pollution samples, assisting in quality control and methods standardization procedures. 0* 0

22AAP-Provision of special laboratory services for monitoring sample analysis

22AAQ-Provision of support for analysis of hazardous pollutants in source samples. 0* 0

22AAR-Provision of routine analytical laboratory support for air pollution samples collected in field monitoring sites. 0* 0

22AAS-Provision of analytical support for air pollutant source samples collected for New Source Performance Standards and for industry studies. 0* 0

22AAT-Field evaluation of commercially available air monitoring techniques. 0* 0

22AAU-Provision of specialized field monitoring support and assistance for pollutants for which no ambient air quality standards exist. 0* 0

22AAV-Development and implementation of methods for analysis of fuels and fuel additive samples collected on a nationwide basis. 0* 0

*funding for these ROAP's presently reside with OAP

| NO. | RPtO | TITLE | FY 73 K | MY | FY 74 K | MY | FY 75 K | MY | FY 76 K | MY |
|---|---|---|---|---|---|---|---|---|---|---|
| 1R1327 | OR&M | Quality Assurance | 0 | 0 | | | | | | |

1. Development and centralization of quality control operations associated with monitoring. PAM- J. Morgan PED-
.Develop standard reference materials and samples
.Prepare and issue procedures and guidelines for EPA's quality control operations
.Evaluate field and laboratory monitoring operations for adherence with standard quality control procedures
.Design and operate an inter and intralaboratory quality control program
.Develop and manage a certification program for laboratories and analysts
.Evaluate and compare alternative methods for the measurement of pollution

22AAW-Development of standard reference materials (SRM's) and delivery systems for quality control for ambient air and stationary sources monitoring 0* 0

22AAX-Development, evaluation, and implementation of guidelines for determining equivalency of ambient air and stationary source measurement methods. 0* 0

22AAZ-Development and implementation of air quality control program. 0 0

*funding for these ROAP's presently reside with OAP

| NO. | RPIO | TITLE | FY 73 K | MY | FY 74 K | MY | FY 75 K | MY | FY 76 K | MY |
|---|---|---|---|---|---|---|---|---|---|---|
| 1R1103 | OR&M | Program Management - Research & Monitoring | 424.4 | 27. | (that portion associated with OM) | | | | | |

1. Managerial functions necessary to overall direction and administration of OR&M, including policy formulation, program area and strategy planning, program review, and direction of program activities.

| NO. | RPIO | TITLE | FY 73 K | FY 73 MY | FY 74 K | FY 74 MY | FY 75 K | FY 75 MY | FY 76 K | FY 76 MY |
|---|---|---|---|---|---|---|---|---|---|---|
| 2F2191 | OCP<br>WERL | Radiation Monitoring | | | | | | | | |

1. Development and operation of the National Environmental Radiation Monitoring Program including collection and laboratory analysis of data; quality control; development of monitoring analytical procedures; and analysis, interpretation, and publication of surveillance data.
   OCP-Overall design and management of the system; development of arrangements with States for the acquisition of data; quality control; and analysis and publication of data.
   WERL and EERL -Collection and analysis of samples; development of analytical methods; assistance to the States.
2. Conduct on-site inspections of installations using radioactive materials or non-ionizing radiation sources to determine if discharges of radioactive materials or radiation levels are within prescribed standards.
   OCP-Manages overall program including development of inspection procedures and schedules; conducts inspections, analyzes data, and prepares reports; reviews and transmits inspection reports to Federal and State agencies.
   WERL and EERL -Conducts inspections; analyzes inspection data, and prepares inspection reports for Headquarters review.
3. Conduct surveillance services for State, local and Federal agencies to assist in the resolution of specific radiological health problems.
   OCP-Determines the need for specific projects; carries on negotiation with other Agencies; and provides direction to laboratories regarding the conduct of projects.
   WERL and EERL -Conduct of assigned projects.

FY 73:

- Conduct ambient monitoring program on environmental radiation levels in air, milk, water, food
- phase out laboratory analysis of network samples
- provide analytical quality control service to Regional laboratories, States, utility companies, other licenses to assure accuracy of environmental radiation measurements
- direct and conduct an in-depth evaluation of radiological aspects of AEC's Hanford operations
- develop and test national environmental radiation analysis and data system for processing, storing, and retrieving environmental surveillance and radiation source data.
- perform field monitoring studies on an operating pressurized water reactor to test developed monitoring methodology.
- prepare contract for development of specific source models for determining population dose for geographical regions and total U.S.
- obtain by contract environmental radiation surveillance data from operating nuclear facilities and other selected radiation sources

.revise national inventory of microwave high power sources having potential public or environmental risk
.complete evaluation of aerial radiological surveys as means for estimating man's exposure from terrestrial radiation.
.maintain aerial radiation surveillance capability to respond to monitoring requirements
.provide automatic data processing facilities to support indoor radon project
.complete aerial survey of Salt Lake City for high radiation levels from uranium mill tailings used in construction
.complete field monitoring program to determine where uranium mill tailings may have been used in construction
.report on results of pilot study using Track Etch technique as a passive dosimeter for radon measurement

| NO. | RPIO | TITLE | FY 73 K | FY 73 MY | FY 74 K | FY 74 MY | FY 75 K | FY 75 MY | FY 76 K | FY 76 MY |
|---|---|---|---|---|---|---|---|---|---|---|
| XF1106 | OR&M | AEC Radiation Effects Program | | | | | | | | |

1. Identify the potential hazards to humans and the environment resulting from nuclear testing activities by field monitoring and laboratory experimenting.

.provide environmental data to establish nuclear testing criteria and radiation protection standards
.perform field monitoring and laboratory experiments on the metabolism of radionuclides in beef, dairy animals, and plants
.perform field monitoring and laboratory experiments on the effects of radiation on soil and plants
.study by field monitoring the transport, distribution and exchange of radionuclides within and between these components

FY 73-74:
.determine the transport of plutonium in man's food chain.

| NO. | RPIO | TITLE | FY 73 K | FY 73 MY | FY 74 K | FY 74 MY | FY 75 K | FY 75 MY | FY 76 K | FY 76 MY |
|---|---|---|---|---|---|---|---|---|---|---|
| XF2196 | OCP-WERL | AEC Off-Site Radiation | 2184.0 | 120.0 | 2230.0 | 120.0 | 2381.0 | 120.0 | 2532.0 | 120.0 |

Carry out field monitoring studies in the environs of the Nevada Test Site. Air, water, and soil samples are routinely collected around the NTS and are analyzed for xenon, krypton and tritium as methane, hydrogen gas, and water vapor. Water samples are analyzed for gross alpha and beta, gamma emitters and tritium. Soil, air filters, urine, vegetation, and animal tissues are collected and analyzed for plutonium.



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